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# Putting the U in carbon capture and storage: rhetorical boundary negotiation within the CCS/CCUS scientific community

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**ABSTRACT**
This paper examines responses to a framing shift from carbon capture and storage (CCS) to carbon capture, utilization, and storage (CCUS) within science and engineering professionals' communication. We argue that the framing shift is a breach in the rhetorical boundaries of the CCS professional community that calls forth negotiation through responses that proactively support, resist, or acquiesce. This study offers a heuristic for examining scientific framing in expert-to-expert internal scientific rhetoric. It also contributes to contemporary research on the intersection of rhetoric of science and science, technology, and society; the social dimensions of CCS; energy communication; and applied communicative practices in scientific communities.

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Carbon capture and storage (CCS) technology (or carbon sequestration) is a significant facet of international deliberation about energy policy, particularly in the face of the climate crisis. In 2005 the Intergovernmental Panel on Climate Change (IPCC) recommended CCS as a primary strategy for climate change mitigation (IPCC, 2005). Further, in the United States, CCS is an important part of President Obama's 'All of the Above Energy Strategy' that assumes the necessity of continued use of fossil fuels to meet an ever-increasing demand for energy within the constraints of climate change ("Advancing American Energy", n.d.). CCS incorporates a wide variety of technologies for the reduction of $CO_2$ emissions from the coal-dependent energy sector and other stationary industrial sources (e.g. cement plants, ethanol plants, refineries, and iron and steel mills) (Department of Energy, 2008; IPCC, 2005). What is referred to as 'clean coal' – or technologies designed to reduce the carbon footprint of coal – serves as one suite of technologies included in the carbon capturing side of CCS (Feldpausch-Parker et al., 2011).[1] We have been involved with research on the rhetorical, social, and cultural dimensions of CCS since the early 2000s. Using rhetorical fieldwork (Middleton, Senda-Cook, & Endres, 2011; Middleton, Hess, Endres, & Senda-Cook, 2015) including

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ethnographic participant observation at annual CCS conferences, we gained access to the everyday expert-to-expert internal rhetoric of CCS-oriented science and engineering professionals.

At the 11th Annual Conference on Carbon Capture, *Utilization*, and Sequestration in May 2012, we observed a rollout of an attempted framing shift from CCS to CCUS (carbon capture, *utilization,* and storage). The rhetoric surrounding this framing shift is boundary-work that constrains and enables the rhetoric of CCS scientists and engineers. During our fieldwork at this conference, we witnessed conference organizers' attempts to rhetorically shift from CCS to CCUS, with the term 'utilization' appearing in all of the on-site conference materials including the welcome signs, name badges, conference programs, and plenary session presentation titles. The conference organizers emphasized the importance of making the business case for CCUS technology through the conference theme: 'Building a Business Case for Carbon Capture, Utilization, & Sequestration … Good for the Economy & the Environment.' Since the 2012 conference, the name change has stuck not only for subsequent annual CCUS conferences, but also in other venues, suggesting that the framing shift has had an enduring effect on the CCS/CCUS community.[2]

In this paper, we turn our attention to the internal rhetoric of the CCS/CCUS technology community in reaction to this framing shift. This community primarily includes scientists and engineers, or people with scientific and technical training in one of several scientific or engineering disciplines who identify as scientists and engineers and engage in work related to the research and development (R&D) of CCS/CCUS technologies. This community includes basic and applied scientists and engineers (Killingsworth & Palmer, 1992) from academic institutions, industries, federal agencies and laboratories (e.g. NETL (National Energy Technology Lab), DOE), public utilities, and NGOs. The CCS/CCUS technology community also includes a small number of non-scientist professionals that are involved in policy, business, or other applications of CCS/CCUS technology. The CCS/CCUS professional community is transdisciplinary in that it is a network of scientists, engineers, and technologists that cross sectors and interest groups in pursuit of a shared solution to a real world energy problem (Sprain, Endres, & Peterson, 2010).

The ubiquitous yet surprising inclusion of 'utilization' into CCS fundamentally changes the nature and purpose of this suite of technologies. Utilization refers to using captured $CO_2$ for an additional purpose before its storage.[3] Although there can be a variety of uses for captured $CO_2$ – including soft drink carbonation, conversion into commercially viable chemicals, remediation of industrial waste, or enhanced oil recovery – in this community, utilization primarily refers to enhanced oil recovery (EOR), a hydrocarbon recovery method for extracting oil from mostly depleted fields by inserting heat, gas or chemicals to displace and release the oil. Captured $CO_2$ is one method of gas injection EOR that the Department of Energy (DOE) argues is commercially viable, supports the *all of the above energy strategy*, and contributes to 'prospects for ultimately producing 30 to 60 percent, or more, of the reservoir's original oil in place' (Department of Energy, n.d.).[4] This connection between CCS and EOR via the CCUS frame has significant implications for the CCS/CCUS technical community.

Putting the U in CCUS created a breach in the community's rhetorical boundaries, temporarily creating a moment 'betwixt and between' (Turner, 1974, p. 41) the old and new frames in which participants responded to and negotiated boundaries – breaking down, reinforcing, and creating anew the boundaries that demarcate CCS/CCUS – associated with the shift. Drawing on rhetorical boundary-work in scientific communities (e.g. Gieryn, 1999; Taylor, 1996) and the cultural performances of social drama (e.g. Turner, 1980), our analysis reveals the rhetorical consequences of the framing shift including proactive support, confusion, modes of resistance, indifference, and acquiescence to the term CCUS and its complex cultural entanglements. Our analysis shows how rhetorical concepts of framing, boundary-work, and social drama routinely appear in everyday expert-to-expert communication in the CCS/CCUS professional community, whether acknowledged or not by the community. An important applied dimension of this research, then, is revealing to the CCS/CCUS technical community the importance of rhetoric to everyday practices of science and engineering.

We begin by further clarifying our theoretical framework to understand the CCS to CCUS framing shift as a social drama that called for rhetorical boundary negotiation within this technical community. Then, we discuss our methodological approach, which uses rhetorical fieldwork to access the everyday rhetoric of CCS/CCUS technologists. Our analysis reveals three responses to the framing shift that highlight differing interests and stances toward CCUS. We conclude with a discussion of the applied and conceptual contributions of this study, with particular emphasis on the ways in which our findings can translate to other energy technologies.

## Rhetorical boundary-work in CCS/CCUS

The change from CCS to CCUS brought with it a new way of conceptualizing the goals, members, and work of the CCS scientific community. Burke (1966) suggests that language creates a terministic screen that frames how people understand their social worlds stating, 'even if any given terminology is a *reflection* of reality, by its very nature as a terminology it must be a *selection* of reality; and to this extent it must also function as a *deflection* of reality' (p. 45). Any message, consciously or not, emphasizes certain things and deemphasizes others. The shift from CCS to CCUS reframes CCS technology as a means for both *using* and storing the captured $CO_2$. This alters the valance of $CO_2$ from a form of pollution that must be captured for climate mitigation, to a commodity that can be used toward further fossil fuel extraction. This reframing created a rupture in the rhetorical norms of the CCS community that intimated different ways of constituting membership, engaging in R&D, and articulating the purpose of the community. This crucial moment between its introduction and eventual adoption called forth a variety of reactions from acceptance to resistance within the CCS/CCUS technical community.

Turner's (1974, 1982) theory of social drama illuminates the process whereby communities (or cultures) attend to conflict through cultural performances. Social dramas represent how communities respond to a particular type of conflict that deliberates about a fundamental change in the norms of a community. Social dramas progress through four stages: breach, crisis, redressive action, and reintegration/recognition. A conflict begins with some sort of norm violation, which leads to a crisis within the community. The breach and crisis importantly signify that this is not an ordinary conflict within the community, but one that contends with the core identity of the community, in this case adding utilization to CCS. Redressive action is the response to this crisis that eventually leads to reintegration into culture or recognition of an enduring difference. Gross (1984) argues that rhetoric is an essential part of how scientific communities move through a social drama.[5] In this case, the framing shift represents a breach in the rhetorical norms of the CCS/CCUS technical community. This breach moves the community into a stage wherein 'what is mundanely bound in sociostructural form may be unbound and rebound,' opening opportunities for redefinition, reframing, remaking, and renegotiating boundaries (Turner, 1982, p. 84). In this case, the breach shifted the boundaries of CCS/CCUS by reframing and reconstituting the shared technology that unites the community, revaluing $CO_2$ as commodity, changing the composition of the community through inclusion and exclusion, and repurposing the technology from climate mitigation to continued fossil fuel extraction. This shift is imbricated not only with politics and power within the professional community but also with external policy constraints on CCS technology. In the U.S., where climate mitigation efforts face stagnating policy directives and CCS technologies are unviable without more stringent formalized climate regulations, CCUS redefines this technology in terms of its economic utility when combined with EOR (Tomski, Kuuskraa, & Moore, 2012).

Moments of conflict within a community not only reflect changing boundaries but also call for boundary negotiation. This framing shift destabilizes several rhetorical boundaries at play within the rhetorical workings of the CCS/CCUS community. Studies of boundary-work and rhetorical demarcation (e.g. Gieryn, 1999; Kinsella, 2001; Kinsella, Kelly, & Autry, 2013; Taylor, 1996) examine the construction and contestation of boundaries, revealing how science functions culturally, socially, and rhetorically. Boundary negotiation can be studied in a variety of ways including a sociological focus on practices, examination of behaviors, or organizational demarcations. We focus on the role of *rhetoric* in boundary (re)construction. The mobilization of rhetorical resources is essential to boundary (re) negotiation, even if the role of rhetoric is often not explicitly acknowledged by scientists and engineers. Indeed, the rhetorical boundaries in a technology community may or may not correspond with more obvious organizational boundaries in the community, revealing how rhetoric is a strong means through which a community defines its boundaries (Happe, 2013).

In highlighting the negotiation of boundaries within this scientific/technical community, we supplement current rhetoric of science (RoS) research that primarily examines the boundaries between science and non-science (i.e. fraud or bad science) or between science and the public (e.g. Condit, 1996; Derkatch, 2012; Holmquest, 1990; Keränen, 2005; Kinsella, 2001). Our analysis highlights the internal boundary-work that happens within a transdisciplinary scientific community after a breach in the community's rhetorical norms. The U in CCUS creates a boundary between what used to be called CCS and the new terminology of CCUS. This boundary marks CCS as an old and unsuccessful approach to CCS and marks CCUS as a new and more successful approach to commercialization and wide-scale implementation of CCS. In creating this boundary, CCUS also breaks down a boundary by combining two extant research programs: CCS and EOR. At the same time, CCUS disrupts a perceived boundary between coal and oil technologies. While it could be argued that in practice, there is no boundary between coal and oil industries, it is important that this boundary had been rhetorically constructed in the CCS community prior to the CCUS frame. Furthermore, the shift to CCUS reflects a response to social, economic, and policy contexts that make it difficult to pursue CCS without utilization, particularly in the United States. Responding to this context, the framers use the CCS to CCUS shift to argue that it breaks the boundary between economy and the environment because utilization in the form of EOR makes CCS (good for the environment) economically viable (good for the economy). Examining these moments of rhetorical boundary (re)negotiation reveals how CCS/CCUS scientists and engineers grappled with the shift and its implications for their community.

## Rhetorical fieldwork

To access and analyze these rhetorical boundary negotiations, we focused on participant observation and informant-directed interviews at the 2012 CCUS conference.[6] Professional science and technology conferences are a relatively understudied site of science in practice (see Heath, 1998; Krauss, 2011). Yet, conferences are an integral space for co-presence and chance encounters (Henke & Gieryn, 2008) where participants converge to present, discuss, and develop new scientific ideas. The 2012 CCUS conference is the site at which the framing shift was prominently introduced. The conference coincided with the DOE's announcement of their shift in R&D focus from CCS to CCUS (McConnell, 2012). This conference was the first opportunity to present the CCUS frame to a large face-to-face gathering of CCS/CCUS professionals, thus providing four of us with a unique opportunity to observe and document the ways conference attendees grappled with the framing shift. A diverse audience of approximately 600 attendees represented basic and applied scientists and engineers from academic, industry, governmental, and NGO segments from 22 countries. Our participant observation yielded fieldnotes, transcribed plenary speeches, and conference materials that we supplemented with analysis of relevant documents, including journal articles and DOE documents that use the term CCUS. We employed rhetorical criticism to analyze these texts. The framework described in the previous section emerged inductively from our analysis.

This form of rhetorical fieldwork allowed us access to internal expert-to-expert scientific and technical rhetoric, artifacts that would otherwise not be documented and analyzed by rhetorical critics (Hess, 2011; Middleton et al., 2011; Pezzullo, 2003). RoS scholars are increasingly turning to qualitative and ethnographic methods as a way to access these undocumented forms of rhetoric (e.g. Baake, 2012; Blakeslee, 2000; Graves, 2005; Ploeger, 2009). Rhetorical fieldwork significantly improves our understanding of the everyday rhetoric of scientists and engineers as opposed to already documented and textualized activities such as journal articles or transcripts of public speeches, which are the traditional texts for RoS research.

Rhetorical fieldwork also has the potential to contribute to the larger interdisciplinary field of science and technology studies (STS) by highlighting the significance of a primarily *rhetorical* approach to understanding the everyday rhetoric of scientists, engineers, and technologists. Using ethnographic fieldwork to examine scientists and engineers is not new to STS. Latour (1988) argues that science is best understood through its sociological practice (see also Woolgar, 1982). Departing from sociology of science laboratory studies, we are interested in the everyday rhetoric of scientists and engineers as they engage in conversations amongst themselves. Using *rhetorical* fieldwork emphasizes the crucial role of rhetoric in the negotiation of boundaries. Happe (2013) notes that 'a rhetorical approach to studying scientific practices opens up space for considering change' (p. 15). In other words, it is through rhetoric that this framing shift plays out.

## Putting the U in CCUS

The CCUS frame was integrated into the entire architecture of the conference, particularly in plenary session presentations. Welcome remarks and plenary session speakers on the first day of the conference set the tone and explained one justification for CCUS. The conference theme 'Building a Business Case for Carbon Capture, Utilization, & Sequestration … Good for the Economy & the Environment' encapsulates the interrelated justifications presented: (1) under a privatized energy system, CCS ultimately must be implemented by the energy industry (with the help or hindrance of other sectors); (2) absent government regulations that limit greenhouse gas emissions and/or put a price on $CO_2$, there is not a reasonable case for the energy industry to implement CCS because it is prohibitively expensive; (3) utilization through EOR puts a price on captured $CO_2$ and therefore makes it more economically viable; (4) utilization through EOR benefits the energy industry by helping it reduce $CO_2$ emissions and retrieve previously inaccessible oil reserves; and (5) utilization through EOR benefits the economy through jobs and the environment through reduction of $CO_2$ emissions. These justifications were not unanimously accepted, as we will demonstrate in our analysis; however, they represent the main argument coming from the CCUS framers. This frame fundamentally shifts the composition and purpose of CCS from a greenhouse gas mitigation strategy to a mechanism to commodify $CO_2$ and extract more fossil fuels. This frame maintains a commitment to fossil fuels, limits the climate mitigation potential of CCS, and assumes a need for increased energy production and consumption.

The Conference Chair, in his introduction of the first speaker at the conference, used the 'business case' terminology to foreground the economic, environmental, and policy benefits of CCUS. He argued that developing a clear role for CCUS in the future of energy was 'maybe some of the most important work going on in the energy sector.' Subsequently the plenary headliner from the DOE stated that U.S. policy has been slow to create a regulatory climate conducive to industry adoption of CCS technologies, but is more amenable to CCUS via EOR because it utilizes carbon as a commodity while also increasing domestic oil extraction. He noted that CCS/CCUS technology needs to remain viable in order to 'keep those fossil fuels a compelling choice in our energy mix in the portfolio of this country because those big stocks and those fuels are abundant, they're secure, they're affordable. We can build business cases around them.' By focusing on available stores of fossil fuels in a prohibitive regulatory environment, the DOE representative rhetorically framed CCUS as the only viable way to make a business case for CCS technologies, thus presenting economics as a crucial frame for energy policy.

This highlights the important linkage between policy and R&D, especially for energy-related technologies (Feldpausch-Parker et al., 2013a). R&D for these technologies is partially grounded in the pursuit of basic science – removed from social consequences – but cannot be separated from applied science and problem-solving (Killingsworth & Palmer, 1992). From the perspective of DOE, which funds much of the basic and applied research on energy technologies, there is a strong interest in deploying and commercializing technologies that meet U.S. energy policy goals. The DOE representative's plenary talk signals that in addition to scientific merit, which was taken as a given, an explicit assessment of both economic and environmental costs and benefits of CCS/CCUS within the prevailing regulatory framework is required to determine potential for deployment and commercialization (Feldpausch-Parker et al., 2013a). Specifically, although the IPCC strongly recommends CCS as a means to mitigate anthropogenic climate change by capturing $CO_2$ emissions, there are high economic and environmental costs associated with R&D and commercial deployment (Johnsson, 2011). It costs money to build and maintain the additional infrastructure needed to retrofit current coal-fired power plants or build new plants with advanced $CO_2$ capture capabilities. CCS also costs energy because a coal-fired power plant fitted with CCS technology needs to burn more coal to produce the same amount of electricity. In a policy framework, these costs are evaluated in relation to the technology's potential to mitigate anthropogenic $CO_2$ emissions within an all of the above strategy (Department of Energy, 2010). Yet, if anthropogenic climate change is not recognized as a significant problem and there are not strong regulations to reduce $CO_2$ emissions, the added costs of CCS are not justified. Without a policy regime that includes a carbon tax or stricter limitations on $CO_2$ emissions, it is not economically rational for industry to implement CCS. Economic rationality assumes a dominant market-based economic decision calculus, but it is important to recognize that this is not the only decision calculus that could be applied. Reframing the technology as CCUS provides a business-friendly alternative that appears economically viable, apparently retains the environmental benefits of CCS, and contributes to other energy policy goals (e.g. Tomski et al., 2012). The DOE representative drove home this relationship between the economy and the environment saying: 'Don't let anybody force you to answer the question business *or* environment. Tell them it's a bad question and our challenge is we're going to answer "yes" to both.' In other words, the sociopolitical context makes it imperative to reframe CCS as CCUS.

Other plenary speakers highlighted the benefits of CCUS. For instance, a representative from an initiative to support $CO_2$-EOR declared that there are no enemies to CCUS, other than the extremes of those who want to eliminate oil and those who do not want to do anything with $CO_2$. This speaker presented CCUS as the obvious choice for anyone falling between these 'extremes.' The DOE representative also voiced his confidence in CCUS as a win–win path: to recover oil, create jobs, generate tax dollars, and get a tangible benefit from capturing and sequestering $CO_2$, thus breaking down the common boundary between economy and the environment. In this framework, the business case is easy: utilize captured $CO_2$ for EOR – 'the unmined gold story in America' – and CCS (as CCUS) becomes viable.

These examples present a significant framing shift. It is not simply adding generic utilization to CCS. Rather, the new frame emphasized only one form of utilization (EOR) within a larger sociopolitical story of building a business case that would be good for the environment and the economy. Gieryn (1999) suggests that 'boundary-work is strategic practical action' wherein borders are 'drawn to pursue immediate goals and interests' (p. 23). CCUS emphasizes U.S. industry and government interests. With CCUS presented as what some participants more accurately called 'CC-EOR-S,' the boundaries of the CCS professional community were expanded to include enhanced oil recovery, while both creating a new boundary between CCS and CCUS and breaking down boundaries between coal and oil, and energy and environment. The ensuing crisis demonstrates that the CCUS framing did not immediately appeal to everyone in the community, but instead enhanced the interests of some members of the community over others.

We observed a variety of responses throughout the conference including confusion, adoption, resistance, disinterest, and acquiescence. The confusion we observed supports our claim that this framing shift was newly presented at this conference and that it created a breach in the rhetorical norms of the community, calling forth rhetorical boundary negotiation. Given that this framing shift specifically promotes industry and government interests within a specific regulatory environment, we might have examined how each bounded organizational sector – academic, industry, NGO, and governmental – within the CCS/CCUS community responded to the shift. However, our analysis reveals that the rhetorical boundary-work that emerged was more complicated than this organizational accounting. We resisted our initial temptation to characterize differing sectors based on a difference between basic or applied research, although we did find more adherence to basic science among the academic sector. We also resisted the temptation to sediment the boundaries of these sectors and overemphasize their importance in the responses to the framing shift. A rhetorical approach reveals to us that the rhetorical boundaries within the community do not always line up with clear-cut organizational boundaries between sectors of the community.

Across all responses to the CCUS frame, there was an underlying confidence that the scientific and technical details of CCS/CCUS, though still in development as evidenced by technical papers presented at the conference, are sound. Given this, we observed that the responses were also strongly focused on the sociopolitical considerations of implementing this technology. We highlight three response categories: proactive adoption, resistance, and disinterested acquiescence.

### *Proactive adoption*

The framing shift benefits a variety of members of the CCS/CCUS community across the sectors including fossil fuel industry participants, the federal government in relation to contemporary climate policy, NGOs set up to promote the implementation of CCS and EOR technologies, and academics working within a funding system that prioritizes CCUS over CCS. These members adopted a proactive stance, as opposed to simply acquiescing to the name change that reinforced the benefits of CCUS.

Proactive promotion of the framing shift reduced utilization to EOR, thus effectively framing CCUS as CCEORS (carbon capture enhanced oil recovery and storage). An executive for a large oil company substituted the 'U' with 'EOR' in his plenary talk title: 'CC-EOR-S.' The framing was pushed further to suggest that CCEORS was really just doing CCS. During the question and answer session during a plenary presentation, an audience participant asked about the differences between CCS and CCUS. After a representative from a CCS institute offered a technical answer, the participant followed up by specifically asking what the 'U' stands for. The presenter responded: 'you are utilizing the carbon dioxide to actually push the oil out.' This is an important moment of defining the boundary wherein the U in CCUS does not reference a variety of utilizations, but EOR specifically. The person who had introduced the two panelists, a representative of an international technology consulting corporation, interjected:

> And just to pile on that point, it's important that when you do see CCUS, and utilize the $CO_2$ for the enhanced oil recovery, you are effectively doing CCS. So to try to discuss it as if it's two

> different things, it really isn't. And that's the whole point of, a lot of theme of [sic] what we're going to be talking about for the next several days here. In terms of a shift, and in terms of people's understanding across the board, utilizing $CO_2$, the "U," allows you to do sequestration. So it really is one and the same.

The responses in this question and answer session do not merely collapse utilization-as-EOR into the only viable form of CCUS, but also attempt to argue that EOR and CCS are one and the same. This rhetoric affects a boundary between what CCUS is and is not and represents a new framework for R&D.

In addition to collapsing the boundary between CCS and EOR, proactive participants used the framing change to sell the argument that CCEORS benefits both the economy and the environment, grappling with a common rhetorical boundary that is ubiquitous both within and outside the CCS/CCUS community. The argument is: (1) CCEORS technology is favorable to the environment because it contributes to mitigating greenhouse gas pollution by storing $CO_2$ emissions in the subsurface; and (2) CCEORS promotes the economy through its potential to generate billions of dollars through increased oil production while also creating employment throughout the capture-utilization-storage cycle. A representative from a large domestic oil and natural gas corporation used his plenary presentation to try to sell the CCUS/EOR story to his direct audience while also asking them to 'Advertise-Tell the EOR Story.' He noted key selling terms in his talk and slides: the potential to 'increase domestic energy supply,' then 'safely store Greenhouse Gases (GHG),' followed by simply 'jobs,' and finally 'environmentally friendly.' This speaker built a vision of $CO_2$ as waste when released into the atmosphere but a commodity for domestic oil production that can then be safely stored for purposes of climate mitigation. The alignment reveals the U as the economic driver that ignites the implementation of CCS' positive environmental benefits. Traditionally, he argued, once CCS is complete the economic cycle stops; but with the addition of utilization, CCEORS becomes economically viable and positive, as the $CO_2$ is utilized to produce profits via oil that would otherwise not be recovered. Although the proactive stance actively engaged both economic and environmental benefits of CCUS, these responses primarily focused on the business case for this suite of technologies, simultaneously breaking and reinforcing the boundary between economics and environment.

Despite the clear benefits for the fossil fuel industry, it was not the only sector of the community that argued in favor of the framing shift. The framing shift also benefits the U.S. government under the auspices of the DOE. For the government segment, the inclusion of utilization-as-EOR purportedly makes CCUS commercially viable while also sustaining the environmental benefits of $CO_2$ sequestration. Maintaining environmental benefits is an important part of the federal government's interest because the DOE is responsible for balancing energy production with climate change mitigation within an *all of the above energy policy*. While there is a weak regulatory environment to support climate mitigation, it is part of the DOE's responsibility through the Federal Energy Management Program to help minimize increases in greenhouse gases among federal agencies.

The DOE National Labs were strongly represented at the conference, including plenary presentations by an Assistant Secretary and other high-ranking DOE and NETL representatives. The government-affiliated scientists and engineers represented in the plenary sessions showed support for the framing shift. As these presenters supported the name change and accepted the implications of CCEORS, they participated in re-shaping the boundaries of scientific action in the community. A representative from a division of NETL devoted to coal R&D aligned the benefits of CCS, CCUS, and EOR in his plenary presentation, titled 'Closing the CCUS/CCS Technology Gap: A Path Forward for NETL.' He explained that the objective of CCS to mitigate greenhouse gas emissions did not change with the name change to CCUS. Rather, the incorporation of utilization via 'tailoring' them to EOR optimized existing CCS projects and technologies. This stance followed the logic that if CCS is a viable and desirable technology that is crippled by its lack of economic feasibility, then it might as well be combined with EOR to make it more economically feasible with the added benefit of producing more domestic oil. Given that contemporary government policy supports the continued use of domestic fossil fuels within the context of a weak climate change mitigation regulatory agenda, it is not surprising that the public rhetoric of the DOE's National Labs supported CCUS (Department of Energy, 2010). Indeed, as we argued above, the DOE is likely the initiator of the framing shift as its announcement of CCUS funding priorities coincided with the conference. Importantly, this support from the DOE has reverberations across the entire community, given that the DOE is the largest funder of basic and applied research on CCS/CCUS technologies.

However, this does not mean that all scientists and engineers employed by the DOE and NETL were also proactive adopters of the CCUS frame. Scientists and engineers employed by federal government entities include both basic scientists working at national laboratories (e.g. NETL, Los Alamos) and applied scientists working within the more policy-oriented parts of the DOE (e.g. Assistant Energy Secretary) resulting in a potential range of opinions. Yet, in this case, their employer has explicitly stated that the frame shall shift (McConnell, 2012). As such, these scientists and engineers had little recourse to openly defy the CCUS frame when speaking on record (including in conversations with us).

This proactive support reveals that the CCUS is much more than a simple acronym change. It refocused the efforts of the professional community from developing CCS as a climate mitigation technology to ensuring its future viability through combining it with one form of utilization via EOR. Proactive support of the CCUS frame not only emphasized economic viability but also called forth a re-focusing of environmental efforts from $CO_2$ mitigation to EOR and oil extraction. This promotion of utilization-as-EOR benefits both coal and oil industry interests and government interests. For the coal industry, it puts a price on captured $CO_2$, which can offset the cost of capture and sequestration. For the oil industry, it provides a means to extract oil remaining from primary and secondary extraction. For government interests, CCUS via EOR not only fit within the all of the above strategy, but also promoted an economically viable mechanism for CCS. Vested industry and government interests composed a particular story around 'CCUS' in an effort to suggest that, once other members of the community understood the story, they would act accordingly.

## *Resistance*

Some community members did not act accordingly and instead resisted the CCUS frame. While the framing shift also serves the interest of some industry-supporting NGOs that are committed to supporting deployment of CCS, EOR, and/or CCUS, several environmentally oriented NGOs resisted the reframe because of its emphasis on utilizing CCS as part of a fossil fuel extraction process rather than an IPCC-approved $CO_2$ mitigation strategy. Further, not all industry participants supported the framing change, particularly those working from international contexts that are less conducive to EOR or more conducive to CCS without the U.

In one session, a panel of experts employed by various energy industries and the DOE gave brief presentations justifying and minimizing the significance of the frame shift, before taking questions and comments from the audience. The response from environmental NGOs was negative, and suggested strong frustration. They explained that, because many of their supporters were already suspicious that CCS enabled continued use of coal and slowed the shift to renewable energy, they had 'their hands full' trying to legitimize support for deployment of CCS technologies, with more than one stating, 'if it's not about climate change we can't support it.' One person explained that, 'we simply can't support CCUS. We've already stretched our credibility almost to the breaking point by supporting CCS when it's focused on innovation. The new label makes it appear you're simply subsidizing business-as-usual.' Another added, 'our members already see CCS as nothing more than methadone for coal addiction. This new term makes it even worse.' Comments such as these prompted barbed replies from industry representatives, including statements that the environmental NGOs were 'hardliners,' 'unrealistic,' and had 'no flexibility.' When we asked about the name change after the session finished, the moderator, who worked for the DOE, responded, 'we had to do it to retain our industry partners. But I don't know; I just don't know.'

In addition to NGOs, there were distinguishable forms of resistance among some industry representatives. The CEO of a Norwegian state-sponsored CCS enterprise rejected the revised focus on making a 'business case' through EOR. Instead, he favored emphasizing that CCS is about climate mitigation. This perspective may have to do with the difference between state-sponsored industrial enterprises and the primarily private enterprises in the U.S. as well as broader differences between European and U.S. sociopolitical contexts related to GHG emissions and climate change. At the time, both national Norwegian and European Union (EU) climate change mitigation goals and policy differed from U.S. goals and policy in their requirement for more stringent controls on $CO_2$. It was not just European industry scientists and engineers that resisted the CCUS frame. The President of a state-sponsored Chinese institute for low-carbon energy solutions similarly rejected the business case. He declared that his challenge was a strategic imperative from the Chinese government to reduce $CO_2$ emissions. He confirmed that business cases were important but stated that without a strategic imperative nothing would work to address climate change. Again, the global orientation of this speaker likely influenced his emphasis. Some U.S.-centered presenters used the framing shift to sell CCUS as something that could revive CCS, perceived to be dying because of a lack of good legislation and regulation. Some international-centered presenters, on the other hand, perceived the business case for CCUS to be less important than the role of CCS in controlling GHG emissions and mitigating climate change. These examples point out how the rhetorical appeal of the CCUS frame is dependent upon a U.S.-centered national sociopolitical context.

Resistance to the CCUS frame defined the boundaries of the community in different ways. These responses primarily sought to position the goal of the community toward GHG reduction, clean(er) coal technologies, and climate change mitigation over the goal of economic viability and increased fossil fuel extraction. While the proactive adopters attempted to show that CCS with EOR breaks down the boundary between the economy and environment, those resisting this frame attempted to keep this boundary intact, or at least value the environment over economic considerations.

### *Disinterested acquiescence*

Differing from the other responses, disinterested acquiescence is primarily correlated with one sector of the community. Scientists and engineers from the academic sector that we observed and talked with took what we perceived to be a passive stance toward the framing shift, dismissing the change and acquiescing in a disinterested manner. While this is not true of all of the academic scientists in our study, some of whom supported or resisted the framing shift, we focus here on the disinterested response because it was common among the academic scientists we encountered. As we will explain, the indifference of academic scientists and engineers to the framing shift was both a form of resistance to the importance of framing in general and a form of passive acquiescence to a shift in focus that would have implications for their interests.

The scientists and engineers who enacted this response mainly described themselves as basic scientists working on small scientific components of CCS/CCUS technologies and expressed more interest in the advance of scientific knowledge than potential applications. Academic scientists congregated around the technical breakout panels much more than the plenary sessions that were geared more toward the new framing. In the technical sessions we attended, we saw little reference to CCUS in the presentation titles, slides, and content, which primarily focused on incremental advances in knowledge about CCS/CCUS science. Many academic scientists were cognizant of the shift in terminology but expressed more interest in the progress of research. They responded with initial confusion yet subsequent disinterest in the shift from CCS to CCUS. For example, in a conversation with an academic scientist en route to the conference, one of us inquired about the addition of the U in CCUS. The conference goer replied indifferently that, apparently, they just changed it, but offered little justification, reflection, or opinion about the change.

Such disinterested acknowledgement carries with it implications for how academic scientists consider the application of their scientific research. In another conversation, an academic scientist discussed how the name change was surprising but ultimately inconsequential to her own research focus. She described her response to the shift as putting faith in smart people to make informed decisions about the name and the application of her research. That is, she believed that others would implement her work in productive ways, which is more important than the new name. This scientist, who also claimed to speak for other academic scientists, was more process-oriented than outcome-oriented; her geologic data could be useful for both CCS and CCUS. As such, the shift was less important to her than her research leading toward generally productive directions, whether for CCS or CCUS. Therefore, although she found the shift from CCS to CCUS a bit befuddling, she perceived it as largely inconsequential to her own research. Compartmentalizing her work from its sociopolitical context and framing, this scientist sees the move from CCS to CCUS as a mere name change, as opposed to a name change that signals a larger rhetorical framing shift that has potentially wide-ranging implications for the CCS/CCUS community. This stance defers to other members of the technical community, such as industry and government scientists and technologist, to make framing decisions.

Disinterested acquiescence to the CCUS frame is a type of value-free, neutral scientific persona that is commonly performed in academic scientist communities. Avoiding discussion of the framing shift enacts a boundary between science and its rhetorical and sociopolitical dimensions, evidenced not only in academic scientists' discourse but also in their decision to segregate themselves by mainly attending only the technical sessions. It is important to note that, given the rhetorical force in the neutral scientist expert public persona, this boundary has proven to be beneficial to many scientists and engineers in their communication with broader publics and policymakers so it is unsurprising that it emerged in our analysis. What is more interesting is that academic scientists and engineers in the CCS/CCUS community assume a boundary within the broader CCS/CCUS technical community between their own engagement with basic research and other scientists' and engineers', employed by industry or federal labs, engagement with application research on deployment and commercialization. These academic scientists sequestered themselves into a subset of the community that upheld a common stance of value-free and neutral science, when discussion of the rhetorical and sociopolitical implications of CCS/CCUS research surrounded them.

Yet, while there can be value in this neutral and disinterested stance, it also has consequences. This stance dissociated the CCUS frame from its significant implications for the research agendas of academic scientists and engineers. The DOE is a major source of funding for research on CCS/CCUS. Shifted priorities in the DOE affect funding decisions and the ability of academic researchers to pursue particular projects. For example, after the framing shift, DOE calls for grant proposals reflected the new priority of projects that fit within CCS as EOR (e.g. Kuuskraa, Van Leeuwen, & Wallace, 2011).[7] These respondents isolated their research from the larger context by assuming their research remained of value to funding sources, no matter what direction that might entail for the implementation of said research. For example, when one scientist stated that forming an opinion on the name shift was not necessary, she dissociated from the rhetorical implications of CCUS for her work.

These reactions can also be seen as subtle resistance to the framing shift. That is, while vested interests in the community took a proactive stance and recognized the importance of framing, these scientists and engineers ignored the importance of framing, simply reacting to it as if it were something meant for others to work out. Rather than resisting the particular frame shift, their rhetoric of scientific objectivity and neutrality was a form of resistance to the idea of framing in general. Their resistance to framing, however, enabled other interested parties to construct the rhetorical terrain as they wished. As CCUS and all that the framing shift enables and constrains gets adopted, vested interests in the technical development of mitigation strategies are being coopted under the commodification of $CO_2$. In other words, while neutrality and resistance to framing can be very useful in certain contexts, particularly those where scientists interact with publics, this case shows that this rhetoric may be less effective in an internal rhetoric within an interdisciplinary scientific and engineering community. Within this community, the academic scientists and engineers who sequester themselves do not see themselves as stakeholders in the discussion in the same way that industry, NGO, and government scientists do. While academic scientists and engineers may see the need for rhetoric in contexts such as congressional hearings on science policy, our analysis suggests that they may not see the importance of the internal expert-to-expert rhetorical interactions happening at these conferences.

## Minding the gap between CCS and CCUS

The 2012 conference's explicit framing shift from CCS to CCUS has important implications for the ongoing practice of the technical community as well as for energy policy in the context of climate change. The introduction of CCUS was a breach in the technical community's rhetorical norms, and our findings offer three categories of immediate responses. While our finding that the shift to CCUS primarily served U.S. industry and governmental interests through the promotion of a business case that shifted the goal of CCS/CCUS from climate mitigation to enhanced fossil fuel extraction may be somewhat unsurprising given the contemporary political context, there is value in providing empirical evidence of the rhetorical boundary negotiation that occurred within the CCS/CCUS community over the new frame. The varied responses reveal the multivocality and competing interests within the CCS/CCUS community and highlight the importance of rhetoric to the everyday functioning of this community. While some of the reactions were temporary 'in the moment' responses that may not represent how people see the framing shift now, understanding this form of expert-to-expert rhetoric as it happened can illuminate how shifts in scientific and technical developments are in part constituted through expert-to-expert rhetoric. This rhetorical approach to boundary negotiation within a technical community highlights how the *rhetorical* boundaries often differ from the organizational boundaries that might be accessed through other approaches, thus showing the significance of applying rhetorical theory to the study of science and technology in action.

Rhetoric matters in the everyday work of scientists and engineers. While this may seem an obvious statement to communication scholars, our analysis reveals that there is resistance to the idea of rhetoric among some scientific and technical communities, particularly among those that identify with basic academic research. In addition to revealing how scientists and engineers use and negotiate rhetorical strategies in internal expert-to-expert communication, our analysis shows that disinterest in or acquiescence to rhetoric is consequential for scientists and engineers. Rhetorical framing may influence grant funding, research opportunities, and energy futures. Those scientists and engineers in the community who embrace and understand rhetorical practice can gain control over and benefit from framing strategies. Those scientists and engineers in the community who resist awareness of framing and other rhetorical devices can be put at a disadvantage, even if they are fundamentally uninterested in the policy applications of their research. Highlighting the importance of rhetorical acuity in the negotiation that occurred in response to this framing shift can reveal the inescapability of rhetoric to scientists and engineers who are skeptical of rhetoric and its material consequences for scientific practice. Explicit rhetorical training for scientists and engineers could benefit those who might otherwise acquiesce to the rhetorical strategies of other interests in the community.

In the case of this specific rhetorical negotiation, the CCUS frame also has important implications for the role of technologists in energy policy deliberation. Reframing $CO_2$ as a commodity has material and discursive consequences for ongoing societal deliberation about energy futures. Industrial-sourced $CO_2$ has been labeled a villain worth curtailing (Feldpausch-Parker, O'Byrne, Endres, & Peterson, 2013b), yet CCUS labels it as a valuable resource. Commodifying $CO_2$ integrates continued fossil fuel production into policy solutions, as opposed to finding ways to phase out fossil fuel extraction. The proliferation of this positive spin on $CO_2$ maintains vested interests in oil and coal (from whatever scientific sector they come) and minimizes efforts to curtail the fossil fuel industry. Bringing rhetorical theory to this topic reveals the important role of scientists' communication in the construction of energy futures. Direct application of communication theory to deliberation about energy futures opens the possibility for tangible contributions to ongoing deliberation, not just in the case of CCS/CCUS but also other energy technologies such as nuclear, natural gas, and renewables.

In addition to practical applications, our analysis also has several implications for communication scholarship. First, it contributes to contemporary research in RoS. While RoS tends to focus either on internal rhetoric among academic scientists or on the relationship between academic scientists and the public (Ceccarelli, 2001), our project uniquely offers insight into the complex relationship between academic, industry, NGO, and government agency scientists and engineers when they come together to interact at a professional technical conference. Further, our use of rhetorical fieldwork to examine this form of expert-to-expert rhetoric documents a previously inaccessible form of rhetoric that is nonetheless crucial to the everyday practice of science and engineering. The theoretical framework that emerged from our fieldwork offers a powerful model for examining similar framing shifts or rhetorical negotiations in science and technology communities.

Second, our analysis contributes to interdisciplinary scholarship on the social dimensions of CCS and energy technologies more broadly. Previous research on socio-cultural dimensions of CCS/CCUS focused on public perceptions and knowledge of CCS/CCUS technologies (e.g. Bradbury et al., 2009; Feldpausch-Parker et al., 2011), or policy contributions to technology implementation (Pollak & Wilson, 2009). These studies suggest limited public knowledge of CCS with varying degrees of acceptance or resistance to the technology. By shifting the focus from expert-to-public to expert-to-expert scientific perceptions of CCS/CCUS, our research taps into an often-overlooked area of study in the social and cultural dimensions of CCS and energy technologies. A better understanding of how scientists and engineers engage with non-technical aspects of their research, such as the social, political, and economic justifications for CCUS, offers productive starting points for better communication between such professionals and energy policymakers.

Finally, our analysis contributes to the emerging field of energy communication (Endres, Cozen, Barnett, O'Byrne, & Peterson, 2016) through its focus on the importance of understanding the role of CCS/CCUS technical professionals in ongoing controversies over energy policy. In legitimating CCS economically through the specific frame of CCUS via EOR, the shift also attempts to legitimate EOR ethically. This attempt to incorporate increased oil extraction into energy policy points out how rhetorical framing can influence the outcomes of policy controversies, and, in this case, may curtail climate change mitigation efforts. For people involved in energy policy and interested in mitigation, our study supports the benefits of recognizing the intersecting sociopolitical and communication aspects of technological mobilization, which is rarely value-free. Such recognition can help stakeholders be more vocal in supporting the kinds of frames that enable the creation of sustainable and just energy policy.

## Notes

1. 'Clean coal' suggests that CCS can make coal clean(er) by reducing its greenhouse gas emissions. Although the term is not considered problematic within the CCS community, neither is it universally accepted. Many scientists and engineers consider it a problematic oxymoron (for more on clean coal see: Schneider, Schwarze, Bsumek, & Peeples, 2016).
2. Hereafter, we use CCS/CCUS to describe the professional scientific community and technologies, reflecting the framing shift's blurring of boundaries. However, we use CCS and CCUS separately when comparing them as distinct frames or when used by our informants and secondary sources.
3. There are many ways in which captured $CO_2$ can be utilized in food, oil and gas, and chemical industries such as food chilling, carbonated beverages, enhanced hydrocarbon (oil or natural gas) recovery, and as raw material for a variety of chemical materials.
4. EOR, also known as tertiary recovery, is a process for oil extraction that generally follows primary recovery (using natural reservoir pressure to extract the oil) and secondary recovery (injecting water or gas to displace the oil in the reservoir). The $CO_2$-EOR process was first used at commercial scales in West Texas in the early 1970s, using $CO_2$ from naturally occurring reservoirs. Today, its applications are being expanded for a broader suite of oil reservoirs located near anthropogenic $CO_2$ sources.
5. Although Turner focuses on rituals as an important symbolic response to social drama, Gross and other communication scholars have shown that rhetorical performances are also used to negotiate social drama (Berg, 1995; Farrell, 1989; Fuoss, 1995).
6. Institutional Review Boards at the University of Utah and Texas A&M University approved our study.
7. Personal Communication, Brenda Bowen (September 17, 2014).

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