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Influencing Attitudes toward Carbon Capture and Sequestration: A Social Marketing Approach

Gabrielle Wong-Parodi,*[,†] Hadi Dowlatabadi,[‡] Tim McDaniels,[‡] and Isha Ray[†]

[†]Energy and Resources Group, University of California, Berkeley, Berkeley, California, 94720, United States

[‡]Institute for Resources, Environment, and Sustainability, University of British Columbia, Vancouver, British Columbia, VCT 1Z4, Canada

Supporting Information

ABSTRACT: Carbon capture and sequestration (CCS), while controversial, is seen as promising because it will allow the United States to continue using its vast fossil fuel resources in a carbon-constrained world. The public is an important stakeholder in the national debate about whether or not the U.S. should include CCS as a significant part of its climate change strategy. Understanding how to effectively engage with the public about CCS has become important in recent years, as interest in the technology has intensified. We argue that engagement efforts should be focused on places where CCS will first be deployed, i.e., places with many "energy veteran" (EV) citizens. We also argue that, in addition to information on CCS, messages with emotional appeal may be necessary in order to engage the public. In this paper we take a citizen-guided social marketing approach toward understanding how to (positively or negatively) influence EV citizens' attitudes toward CCS. We develop open-ended interview protocols, and a "CCS campaign activity", for Wyoming residents from Gillette and Rock Springs. We conclude that our participants believed expert-informed CCS messages, embedded within an emotionally self-referent (ESR) framework that was relevant to Wyoming, to be more persuasive than the expert messages alone. The appeal to core values of Wyomingites played a significant role in the citizen-guided CCS messages.

INTRODUCTION

Without substantial reductions in the emissions of greenhouse gases from the energy sector, it will be impossible to avoid catastrophic climate change.[1] One possible technological solution is carbon capture and sequestration (CCS), where CO_2 emissions are captured from stationary sources such as coal-fired power plants and stored deep underground.[2] This solution, while controversial, is seen as promising, because it will allow the United States to continue using its vast fossil fuel resources and existing energy infrastructure in a "carbon constrained world".[3,4] With today's technologies, retrofitting a coal-fired power plant with CCS is extremely expensive.[4] Thus, energy engineers are very interested in developing projects at minimal cost and risk, located at geologically well characterized sites, where mineral resources can be extracted at profit. For at least the first round of projects, therefore, should CCS become part of U.S. climate policy; the technology will be deployed in places that already depend on mineral extraction and fossil-fuel-based electricity generation. At these sites, livelihoods are heavily dependent on the health of the local energy sector.[5] In this paper we refer to people living in such places as "energy veteran" (EV) citizens.

History has shown that the U.S. public reacts quickly and negatively to accidents both in the production of energy,[6] e.g., the Three Mile Island reactor meltdown (1979), and in the extraction of resources, e.g., the Deepwater Horizon oil spill (2010). These and other events have contributed to the public's general suspicion of the energy industry, and surveys suggest that these negative views extend to CCS.[7] The public seems to think of CCS as similar in scale and risk to that of nuclear energy, even in the face of evidence to the contrary.[7] Some see this technology as pointless when more appealing alternatives such as solar power exist.[8,9]

CCS policymakers and industry officials know that without public acceptance, formal or implicit, it is unlikely that the technology will go to scale in the U.S. Research is beginning to move beyond the investigation of the public's perceptions of CCS, toward developing strategies to effectively engage with the general public. In recent years, studies have shown that CCS information used in research[10] and for public education[11] is of poor quality, tending to produce "pseudo-opinions" that are easily changed.[12] If the quality

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of the information is improved,[12−14] however, participants can form stronger and more favorable views of the technology.

Recognizing the importance of public support, CCS proponents have launched a "clean coal" campaign designed to influence the attitudes of the general public (www.AmericanPower.org). The messages put forth by these efforts focus on how CCS could contribute to energy independence and economic stability. For the few CCS experiments conducted at places with an EV public, the approach has been to communicate messages that emphasize technical and risk expert information. Such communication efforts at the Department of Energy's CCS pilot sites did not garner positive attitudes toward the technology, but rather seemed to have the opposite effect.[9] Largely anecdotal evidence from other countries supports this observation, where several small-scale CCS experiments have been shut down in part due to local protest.[15−18]

This paper does not analyze, or take a position on, the arguments in favor of or against CCS as a rational response to mitigating climate change. Rather, we recognize that the public is an important stakeholder in the national debate about whether or not the U.S. should include CCS as a significant part of its climate change strategy. Understanding how to effectively engage with the public about CCS has become important in recent years, as federal and energy industry interest in the technology has intensified. Engagement efforts should be focused in places where the technology will be first deployed, which are mostly places with EV citizens. Early deployments often set the tone for future deployments, and local protests have been rallying points for larger social movements against large-scale energy technologies.[19,20] We suggest that social marketing, or the application of marketing techniques to achieve social change, is an effective approach toward engaging with the public about CCS. In this study we develop a citizen-guided social marketing approach toward understanding how to influence EV citizens' attitudes toward CCS.

Role of Emotionally Self-Referent Triggers in Persuasive Messages. What little research has been done on CCS-related messages for citizens has centered on creating easily digestible and readily understood messages.[9] This work is influenced by dual process models,[21,22] which posit that if the message is "well designed", meaning that it is well reasoned, contains relevant information, and appeals to the logic of an able recipient, then it should be successful. By these criteria, CCS messages developed to date are well designed—they contain "expert" approved information presented in an attractive and logical manner.

Mounting evidence suggests that the best messages are not only informational and logical, but also trigger an emotional response in recipients.[23] These emotional "triggers", it is argued, tend to induce thoughts about the recipients' sense of identity.[24] "Emotionally self-referent" (ESR) messages are better remembered, and are viewed as more persuasive than those that do not arouse such a response. Emotionally self-referent messages may also have the additional benefit of being talked about with recipients' friends and families. Research suggests that exposure to these messages encourages discussion, wherein information flows through social networks, potentially influencing those not exposed to the original message.[25,26]

We argue that an effective CCS campaign aimed at changing EV citizens' attitudes should target the multiple channels through which an individual is influenced. A useful starting point would be a systematic investigation of the emotional *and* informational elements that could comprise a persuasive message about the technology. Although ESR-type messages have a long history of use in public health and political campaigns, they have not been applied to carbon management technologies in the energy policy domain.

We also argue that emotional triggers in a community are best identified from within that community. We therefore relied on the expertise of EV citizens to develop the ESR messages most likely to affect attitudes. To do this, we divided our study into two parts. For the first part, we identified the triggers that elicited thoughts about identity for our study group of EV citizens—the Wyoming public. For the second, we had our EV citizens use these triggers to develop emotionally self-referent messages with respect to CCS. They compared these messages to expert-developed CCS messages to analyze which were the most and the least persuasive in promoting CCS to the Wyoming public.

Wyoming: A State of Energy Veteran Citizens. For Midwest states that rely heavily on the revenues generated from coal-related exports, the "writing is on the wall".[27] Their industry is threatened by policies enacted in other states, for example California's 2006 Global Warming Solutions Act, that limit the CO_2 to be emitted during the generation of electricity. A perceived threat also comes from the development of advanced power plant technology such as Integrated Gasification Combined Cycle (IGCC). Designed to remove virtually all pollutants such as SO_2, large-scale IGCC deployment may eliminate the cost advantage enjoyed for the past few decades by low-sulfur Midwest coal.[28]

More than in any other Midwest state, coal is king in Wyoming. In 2009, mining operations comprised more than 90% ($3.45 billion) of local and state revenue. State assessments suggest that three secondary jobs are created for every direct industry job, making the fossil fuel industry the single most important employer in the state.[5,29] But times are changing and, to protect their coal industry, Wyoming state and industry officials know the state must adapt.

Over the past decade, policymakers and industry officials have advocated that the state move away from being an exporter of coal (a low-value "shovel-and-ship" industry) to becoming an exporter of coal-generated electricity (a high-value industry). In the face of evolving national priorities on climate change where coal is now seen as "dirty", IGCC and CCS have been embraced as a way for the state's coal industry to stay afloat. State legislators have taken many steps to foster the development of CCS-related activities, such as submitting a proposal for FutureGen and passing the "CCS statutes".[30−32]

To date, several government and industry-funded projects have been proposed, and some are in the process of being implemented. The "Wyoming Underground Storage Project" near Rock Springs, WY is generally considered to be the most successful. Characterization of the underlying geology began in 2009 with $4.95 million federal funding. Project developers are now in the process of obtaining building permits, and they plan to start construction in the next few years. In late 2010, the federal government promised $5 million in additional funds for the project.[33] Wyoming's EV citizenry and its proactive policies to foster the development and deployment of CCS make it, perhaps, the best place to learn how to develop persuasive CCS messages.

■ PART 1: EMOTIONALLY SELF-REFERENT TRIGGERS FOR WYOMING

It would be impossible to develop emotionally self-referent triggers without expert assistance. In our study, the relevant

experts are Wyoming citizens. To identify what their triggers might be, we conducted 20 open-ended face-to-face interviews with selected participants in Wyoming. Without mentioning CCS, we asked each participant just one question: "what specific values identify you as a Wyoming citizen?"

Throughout this study, we recruited our participants by snowball sampling. We were well aware of our outsider status in Wyoming, and decided that this method would be the best way to gain access to, and the trust of, our participants. Through a review of U.S. census data and with help from the University of Wyoming's Energy Center, we determined that there were subcommunities defined largely by local economic activities: tourism, government, mining, and education. With the assistance of the Energy Center, we recruited "key informants" in each type of community—Laramie (education; home to the University of Wyoming), Cheyenne (government; the state capital), Gillette (mining; the self-proclaimed "energy capital of the world"), and Jackson (tourism; gateway to the Grand Teton and Yellowstone National Parks). With the help of our key informants we recruited participants in each community. Thus our purposively drawn sample included state legislators (including the CCS statutes coauthors), ranchers, educators, housing developers, media representatives, members of the Governor's cabinet, and geologists.

As our sample is purposive rather than random, we present and analyze only those responses that were frequently expressed; such responses are more likely to be illustrative of the broader EV citizenry in Wyoming. Through a content analysis of our interview notes, we identified five Wyoming ESR triggers (or values): state independence, locals versus outsiders, outdoor space, lifestyle, and water (see Table 1). The term "value" was not predefined for the participants, and values expressed were ones seen as being nearly universal for the people of Wyoming (see Supporting Information (SI)).

Whereas these triggers were reported as capturing the essence of WY citizens' sense of identity, our interviews suggest that their relative importance may differ among subgroups of citizens with differing relationships to the energy industry. Four professional categories emerged (see Figure 1): policymakers (local and state), energy industry employees, ranchers, and broader community members. By no means does membership in one group exclude membership in another; e.g., a rancher in Gillette raises cattle and also leases her land to an oil company.

The identification of the ESR triggers was only our first step toward understanding how to develop a persuasive message about CCS. In the next section, using what we learned from our initial interviews, we asked a new set of Wyoming participants to design emotionally self-referent CCS marketing messages.

■ PART 2: CITIZEN-DESIGNED EMOTIONALLY SELF-REFERENT CCS MESSAGES

Developing ESR CCS Messages. We developed an interview protocol designed to elicit views about CCS, as well as to understand views of the technology in relation to the ESR triggers. Based on the responses from the "trigger" interviews we conducted in April 2010, we developed and pretested this CCS interview guide in May 2010 in Berkeley, California. With the help of the Energy Center, we refined the guide and piloted it in Casper, Wyoming—once a hub of industry in the state. Based on our interviews in Casper, we tailored the guide for the final study.

Table 1. Most Frequent ESR Triggers Identified from Interviews with WY Participants

trigger	definition
state independence	state sovereignty
water	resource scarcity; conflict between states
locals versus outsiders	transient workers; shallow family roots in Wyoming
outdoor space	nature's beauty; recreation, e.g., hunting and fishing; stewardship
lifestyle	say what you do, do what you say; work to live, not live to work

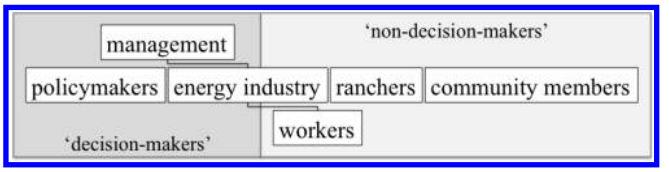

Figure 1. How participants were categorized into groups for our analysis. In all we had 8 partially overlapping groups.

Whereas most citizens in the state are familiar with its energy industry, for this part of the study we decided to recruit participants who live where commercial CCS projects may occur in the future. We recruited in the two largest mining communities: Gillette and Rock Springs. All of our participants were EV citizens. They were already aware of CCS and many had loosely formed opinions of the technology prior to their participation in this study. Therefore the provision of educational materials on CCS, which surveys with the general public often require, was not needed.

Gillette, where we conducted 18 interviews in July 2010, is *the* coal-mining town. Most of the town's 25,293 residents[34] are directly or indirectly employed at one of its six coal mines. More coal (90%) is mined in this area than in any other in the state, and a quarter of all coal consumed in the U.S. comes from the Gillette area alone. Rock Springs, where we conducted 21 interviews in July 2010, is an older and more well established community than Gillette. Many of its 18,708 residents are employed at the local trona mines, and some are employed by coal and natural gas operations (see SI for more information).

We found that while the ESR triggers may be (nearly) universal, their relative importance varies by subsets of the state's population. Because a CCS campaign in Wyoming could be more effective if it included multiple CCS messages targeted at these subsets, we recruited from each of these groups in each community (Figure 1): policymakers, energy industry managers and employees, ranchers, and community members not directly related to the energy sector.

The CCS interview began with several open-ended questions such as "What are the challenges facing Wyoming over the next 20 to 25 years?" Then we had our participants design a "CCS campaign" in which, based on their responses during the interview, they created either a statewide pro- or anti-CCS marketing message. We had some of the participants develop messages contrary to their stated opinion of the technology. We did this to

encourage our participants to share views they believed to be persuasive not only to themselves, but that might be persuasive to others. This activity involved several steps.

We first asked our participants what persons, groups, and/or institutions they believed would be trusted sources of information. Second, we assessed the relative importance of each ESR trigger by having our participants rank them (from 1 to 5) by what was most central to their own sense of identity as a Wyomingite. When questioned, without exception, every participant confirmed that the ESR triggers were central to their sense of identity. "I would say these values," said an older Rock Springs librarian, "are what connect the people of Wyoming" (RS7).

Third, we asked our participants to design a statewide pro- or anti-CCS marketing message using the ESR triggers. We asked our participants to imagine that they had a fixed pool of resources (i.e., money or time) from which they could draw to develop their message. Then, using an interactive budget allocation tool (see SI), we had our participants divide the pool of resources among the ESR triggers (Table 1). Our underlying assumption was that larger resource allocations to specific triggers would be a proxy for greater emphasis to be placed on those triggers in a hypothetical CCS campaign. While the participants were using the allocation tool, we encouraged them to follow the Think Aloud Protocol;[35] this protocol asks participants to describe what they are looking at, doing, thinking, and feeling. We did this so that we could better understand both what our participants believed to be a persuasive CCS message for their fellow Wyomingites, as well as to understand why they thought so. The Think Aloud method can sometimes lead to illogical or unrelated utterances and possible cognitive overload;[35] we tried to mitigate these disadvantages by asking the participants follow-up questions to ensure that they had expressed themselves to their satisfaction.

Fourth, to gauge the importance placed on CCS we asked our participants to estimate how much should be spent on a pro- or anti-CCS campaign to be successful—one generating CCS support or rejection. To help our participants with their estimates, we provided them information on how much was spent on advertising for the last gubernatorial election.

Finally, we showed our participants six expert-developed, primarily informational, CCS messages (Table 2), drawn from a range of economic and scientific assessments. We asked them to rank these (from 1 to 6) in the order they believed would be most important to an average Wyoming citizen. Then, we invited our participants to rerank the ESR triggers with respect to their CCS messages. We encouraged the participants to include the expert messages in this reranking if, and where, they saw fit. During the ranking exercises, we again asked our participants to tell us aloud what they were looking at, doing, thinking, and feeling.

Analysis. *ESR Triggers.* We had our participants rank the ESR triggers on a scale from 1 to 5, with 1 representing the trigger most important to their identity as Wyoming citizens and 5 being the least. Given our small and purposive sample, we could not assume that the rankings for the groups were either normally distributed or fully representative of the larger population. To get a sense of the magnitude of differences in the ranking of the ESR triggers among the groups, we employed robust nonparametric tests. We used the Wilcoxon test (chi-square for 2 groups) to assess the differences in means between our two communities (Gillette vs Rock Springs) and status (decision-makers vs non-decision-makers). We used the Kruskal−Wallis test (chi-square for 2 or more groups) to assess differences by profession. If a trigger were equally important between two or more groups (e.g., between Gillette participants and Rock Springs participants), we would expect an average rank of 2.5 (based on a scale of 1−5).

Table 2. Expert CCS Messages Drawn from a Range of Current Scientific and Economic Assessments (see SI)

trigger	definition
benefits to Wyoming	local benefits, e.g., employment; encourage cleaner energy market
suited to Wyoming	well-developed energy sector; well-characterized geology
a known technology	used for enhanced resource production; used for acid gas disposal
costs	raise electricity costs; power plants likely to regulated in the future
low expected risk	low risk; lower risk with good site selection and appropriate technologies
climate change	CCS will reduce CO_2 emissions from fossil fuel fired power plants

ESR CCS Messages and Expert CCS Messages. The resource allocation to each ESR trigger for the CCS campaign comprised the heart of their persuasive CCS message. To assess the importance of each trigger, we took the average of the percentages allotted to each ESR trigger to identify the "average CCS campaign". We took this average campaign allotment and mapped it in Figure 2. Each bubble represents one ESR trigger and the size of the bubble corresponds to the percentage allocated to it. We also had our participants rank the expert CCS messages on a scale from 1 to 6, with 1 representing the message most important to them. We performed a similar analysis for the expert CCS messages as we did for the ESR triggers.

To get a sense of the magnitude of the differences in resource allocation among the groups, we again employed nonparametric tests. We used the Wilcoxon test to assess the differences in mean percentages allocated for each trigger between our two communities and status. We used the Kruskal−Wallis test to assess differences by profession. If a trigger were equally important as all the other triggers for a particular group, we would expect to see an average resource allocation of 20%. If there were no differences between groups we would expect to see average allocations of 20% for each trigger for all groups.

To better understand and contextualize our results, we performed a content analysis of the interview transcripts. Through this analysis we assessed the sources that our participants believed would be trusted with respect to encouraging or discouraging CCS, as well as their views on CCS and how it related to the energy industry.

Results. *ESR Triggers.* On balance, our participants ranked lifestyle (M = 2.16, SD =1.26) and outdoor space (M = 2.18, SD =1.16) higher than the other ESR triggers (see Table 3). The trigger ranked as least important was locals versus outsiders (M = 4.39, SD = 1.17).

ESR CCS Messages and Expert CCS Messages. The maps in Figure 2 represent the allocation decisions by all our participants and by community groups for the CCS marketing message. For the average CCS campaign, our participants allocated nearly half of their resources to lifestyle and locals versus outsiders (25% and 24%, respectively). Next, they allocated 20% of their resources to

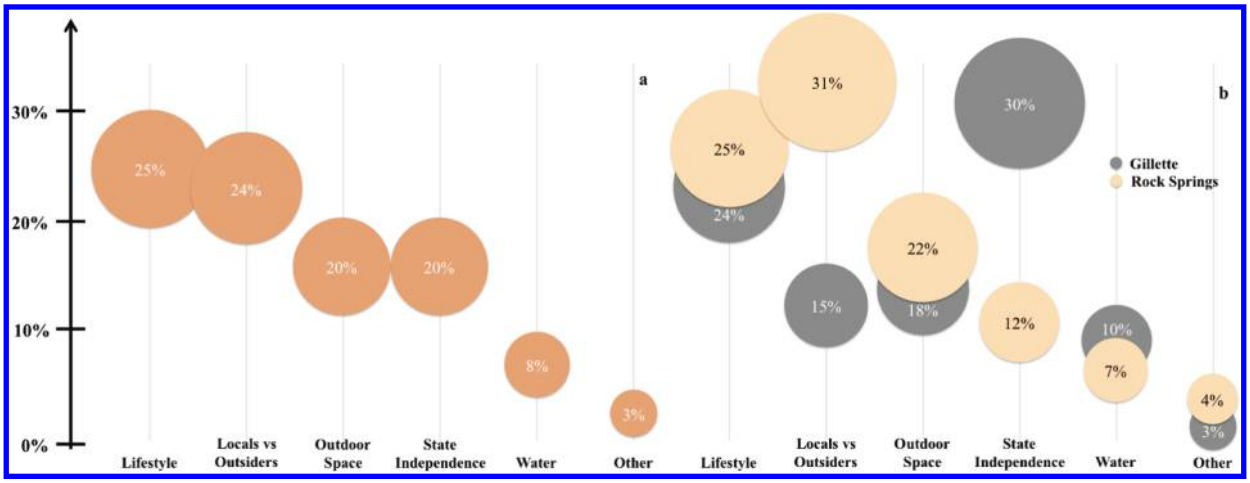

Figure 2. Graphical depiction of the average percentage of resources allocated for each ESR trigger for a persuasive pro- or anti-CCS message for all of our participants (a) and by community (b).

Table 3. Average (and Standard Deviation) Rank for Each ESR Trigger for the Groups, As Well As for All of the Participants (1 = Most Important, 5 = Least Important); A Low Average Value Means That the ESR Trigger Was Considered More Important than the Other Triggers

	lifestyle		outdoor space		water		state independence		locals vs outsiders	
	M	SD	M	SD	M	SD	M	SD	M	SD
community										
Gillette	2.61	1.42	2.39	1.33	3.11	1.18	3.11	1.18	4.28	1.41
Rock Springs	1.75	0.97	2.00	0.97	2.60	1.39	3.15	1.18	4.50	0.95
status										
decision-makers	1.67	1.02	2.00	0.89	3.05	1.36	3.29	1.19	4.19	1.21
nondecision-makers	2.76	1.30	2.41	1.42	2.59	1.23	2.94	1.14	4.65	1.11
profession										
policymakers	1.75	1.16	1.63	0.52	3.00	1.51	3.50	1.31	4.38	1.06
energy industry	1.83	1.11	2.58	0.79	3.33	1.07	3.25	0.97	4.58	1.24
rancher	2.29	1.38	2.29	1.70	2.86	1.35	2.57	1.27	3.86	1.35
community members	2.80	1.40	2.00	1.41	2.30	1.25	2.90	1.10	4.60	1.17
all participants	2.16	1.26	2.18	1.16	2.84	1.31	3.13	1.17	4.39	1.17

outdoor space and 20% to state independence. The rest was given to water and other topics.

According to our respondents, a persuasive pro-CCS marketing message would open with how CCS would enhance their lifestyle and enjoyment of outdoor space. Then it would move to how CCS does not threaten jobs (locals versus outsiders) but instead retains, and maybe even creates, jobs. The message would then show how the development of the technology in Wyoming contributes to and maintains state independence. A state senator, for instance, said that he would say, "we are tired of the federal government coming in and telling us how to run things when we can do this ourselves" (G16). Although water was not seen as central to a persuasive message, our participants said they would mention that CCS would not adversely affect water quality or supply.

The most commonly formulated anti-CCS marketing message rested on exactly the same triggers and exactly the same order of triggers as the pro-CCS message. The difference lay, our participants said, in how they would "spin" each of the ESR triggers. For the anti-CCS message, our participants would open with how the technology might adversely affect their lifestyle and outdoor space. A historian in Rock Springs said he would say how CCS "negatively affects...my lifestyle in terms of me backpacking and seeing no signs of man" (RS1). The message would move on to how the technology threatens jobs (locals versus outsiders). One coal miner in Gillette responded that he would say, "we [Wyomingites] don't want outsiders here, even if it hurts our economy" (G2). The message would suggest that CCS is being considered by the state only because of federal pressure (state independence), and conclude with how the technology, because it is not yet proven, could threaten water quality and supply.

When we compared the CCS message maps by our different groups, we found differences in how resources were allocated by community. Our Gillette participants allocated significantly more resources to state independence than our Rock Springs participants ($\chi^2 = 10.65$, $p = .00$). Our Rock Springs participants allocated significantly more of their resources to locals versus outsiders ($\chi^2 = 8.96$, $p = .00$). Our data do not allow us to explain these intergroup differences, however.

Table 4. Average (and Standard Deviation) Rank for Each CCS Expert Message for the Groups, As Well As for All of the Participants (1 = Most Important, 6 = Least Important)

	benefits		suited to Wyoming		known technology		low expected risk		costs		climate change	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
community												
Gillette	3.06	1.70	2.67	1.81	2.83	1.15	3.72	1.53	4.11	1.60	4.78	1.96
Rock Springs	1.60	1.31	2.40	1.50	3.20	1.54	3.75	1.94	3.95	2.11	3.90	2.31
status												
decision-makers	1.71	1.10	2.05	1.07	3.14	1.31	3.62	1.83	4.33	1.77	4.86	1.80
nondecision-makers	3.00	1.97	3.12	2.03	2.88	1.45	3.88	1.65	3.65	1.97	3.65	2.45
profession												
policymakers	1.88	1.25	1.63	1.30	2.63	1.51	3.88	2.10	4.50	2.27	3.75	2.31
energy industry	1.67	1.07	2.42	1.24	3.50	0.90	3.33	1.44	3.67	1.30	6.00	0.00
rancher	3.00	2.00	3.14	1.77	3.00	1.29	4.14	1.21	4.57	2.15	3.86	2.27
community members	3.00	2.05	2.60	1.84	2.50	1.43	3.60	2.12	3.90	2.02	3.30	2.41
all participants	2.29	1.66	2.53	1.64	3.03	1.37	3.74	1.73	4.03	1.87	4.32	2.17

On balance, a trusted source to deliver the CCS message would be one seen as unbiased ("no bias...100% no bias" (RS12)), down-to-earth ("not just some hotshot, but somebody who has been though the good and bad times" (G16)), and native-born ("These guys are natives, they have grown up with the cattle industry and the oil discovery. That's a lot of credibility in our community, I think, if you have those roots" (G17)). Untrustworthy sources are energy industry representatives: as one male rancher in Gillette put it, "Basically you can't trust anybody anymore. Especially people in the energy industry because they'll lie" (G3). Another untrustworthy source would be "elite" environmentally oriented nongovernmental organizations. A local conservative radio personality said emphatically, "it *can't* be environmentalists" (G6).

We found differences by status as to how the CCS campaign should be presented. Although all agreed that local and state policymakers would be trusted, non-decision-makers strongly believed that, given Wyoming citizens' preference for "hands-on" campaigns, community members delivering the message would be best. A coal miner in Rock Springs suggested that "a collective of local citizens who would be formed to study the issue and present the results" (RS19) could be a successful way to deliver a pro- or anti-CCS message. Our ranchers recommended that "a cowboy-type or agricultural representative" (G3) would be trusted, because they would be perceived as having no vested interest in the energy industry. Unprompted, several participants suggested that the most effective way to reach Wyoming citizens would not be through media outlets but rather through their workplaces or community meetings ("take it to every Lions Club in the state and have a speaker" (RS17)).

When asked to rank the expert-developed CCS informational messages, our participants ranked benefits (M = 2.29, SD = 1.66) and suited to Wyoming (M = 2.53, SD = 1.64) higher than the other CCS expert messages (see Table 4). The message ranked as least important was climate change (M = 4.32, SD = 2.17), though climate change is the main reason for policy-level interest in CCS.

Our participants did not see their emotionally self-referent CCS messages as supplanting the more traditional expert points of view. Rather, they argued that CCS expert messages should go "hand-in-hand" (RS11) with the ESR triggers to create a message that would be part of a successful (pro- or anti-) CCS campaign. One Rock Spring participant reflected on the primacy of ESR triggers in her CCS message, "you have to draw out the emotion. You...have to get it, so they [Wyomingites] wonder how this affects them" (RS7). Most reshaped their original campaigns to include some of the expert messages, but retained the ESR message's centrality.

A pro-CCS message (see Figure 3) that includes the expert messages would focus on how the technology would positively affect lifestyle and outdoor space, mediated by benefits. An energy industry executive in Gillette said, "the only way I can think to run a campaign like that is if you showed people that it would create more jobs—because it is about the only argument you can present" (G16). The link between benefits and lifestyle and outdoor space would be a central message, where the important questions would be: "How can I be employed at a reasonable salary to do things? How is it [CCS] going to affect hunting and fishing?" (RS4)

An anti-CCS message focuses on the same ESR triggers, but highlights the expert messages most likely to generate suspicion or anger by Wyomingites (see Figure 3). For example, a coal miner in Gillette (G16) augmented his original anti-CCS message to include the expert messages:

> "...well these, actually all three of these (gestures to CCS expert message in front of him) would have an impact on nature. You can certainly use the argument that it is going to hurt our nature here...lifestyle...and from the standpoint of nature and water. Um. Again, state independence is related to global warming...climate change is something that the feds have dreamed up and they are shoving it down our throats. Locals versus outsiders go along with this. You know, we don't want the outsiders here."

DISCUSSION

From our study of energy-sector veteran residents of Wyoming, we conclude that our participants believed that expert-produced informational CCS messages, embedded within an ESR framework that was relevant to Wyoming, were more persuasive than the expert messages alone. Indeed, our participants thought that the

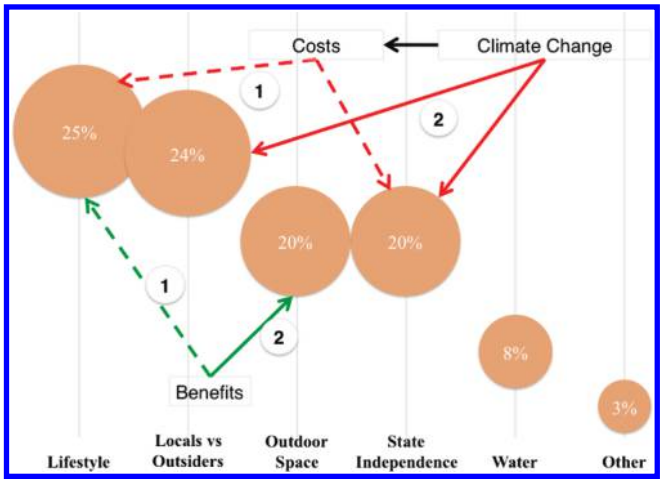

Figure 3. General pro-CCS message including the average pro-CCS expert message (green), and the anti-CCS message (red). A pro-CCS marketing message would include how benefits (1) allow for the Wyoming lifestyle, thereby (2) enhancing Wyomingites' enjoyment of outdoor space. An anti-CCS marketing message would include how CCS will (1) cost jobs and threaten lifestyle thereby reducing Wyomingites' ability to enjoy outdoor space. Then, it would explain that climate change is a problem (2) created by outsiders (meaning, the federal government) and will mean fewer jobs (transient workers), and therefore threatens state sovereignty.

most persuasive pro- or anti- CCS campaigns should lean more heavily on the ESR triggers. The triggers themselves do not change, no matter the intent of the message. However, the relative importance placed on these triggers appears to differ by subsets of the population, and any CCS campaign should be sensitive to those differences. Potentially, a successful way to influence EV citizens' attitudes toward CCS would appeal to the place-based values and identity issues they find most important. The expert-based information on CCS is important, but for the purposes of influencing attitudes it may be secondary.

Our findings show only what our participants believed would be persuasive CCS messages, and not what actually are persuasive messages. Future research should test this social marketing approach to assess the degree to which citizen-guided messages are indeed persuasive. One possible way to do this would be to have members of an EV public "vote" on a fictional CCS referendum after exposure to information about the technology, after the technology is presented either within an ESR framework or alone. Furthermore, while our findings suggested that ESR triggers are key to a persuasive CCS message, there may be a distinction between an ESR trigger that is important and one that is persuasive. For example, our participants ranked locals versus outsiders as low in importance relative to the other ESR triggers, but allocated a substantial portion of their resources (24%) to it for their persuasive CCS message. There are a number of different models that might explain our findings. First, ESR triggers may have multiple and contextual meanings for our participants.[36] Alternatively, certain ESR triggers may require more cognitive effort to understand than others and therefore may not be emphasized in a persuasive CCS campaign.[37] Finally, lower ranked triggers may be used in order to appeal to the broadest audience possible.[38] Further study is need to understand the contribution of these models to our participants' selection of ESR triggers.

Although not enthused about the technology, our EV citizens saw the energy industry, and coal in particular, as the state's "bread and butter" (G1). Coal, they reported, kept the state running, and the state gave them the resources necessary to fund their independent, outdoor-loving, you-work-to-live self-image. If CCS were the way to maintain that identity, then they would be for it, and believed that their fellow-citizens would be, too.

Social identity theory posits that people derive part of their identity from their group membership, and that this social identity has emotional significance.[39] Our EV citizens' sense of identity—Wyomingite—was a product partly of birth and partly of self-selection. The economic and political pressure from the outside (which includes the federal government) was seen as an attack on the coal industry, as well as on the collective values held dear by Wyomingites. The increasingly negative rhetoric around coal was perceived as a personal attack against Wyomingites themselves. These factors fueled the fear that Wyoming's social identity was under threat, further causing the participants to defend the integrity of the "ingroup".[40] Almost all participants expressed resentment at the power of "outsiders" over the "locals": one city commissioner said ruefully, "we've been a colony here our entire history...a lot of our economy is run by multinational companies who couldn't even find our state on a map in their board room" (G18).

The strategy adopted by decision-makers in the state has been to use "outgroup" political and economic pressure to do something about coal, as an opportunity to "save" the coal industry through CCS. Thus, they are able both to maintain the status quo by keeping the industry in place and try to increase Wyoming's status by promoting the state as "technology pioneers" (G2) and "energy policy leaders" (G11). The rest of the population, in effect, goes along with this plan, because so many of them are either indirectly or directly dependent on the mineral extraction industry. For Wyomingites, at stake is not just their financial security but also the very fabric of their society.

Difficult decisions about what carbon management technologies to invest in will need to be made over the next few years if the U.S. wants to make a meaningful contribution to the mitigation of climate change. In many instances this will require energy veteran citizens to assume the local burden of living close to these potentially risky technologies for the benefit of the nation. Furthermore, EV citizens will be asked to assume an unknown financial burden, potentially costing jobs and undermining a valued way of life.

This study is premised on the understanding that the public is an important stakeholder in the national debate about CCS, and, given growing interest in the technology by policymakers and energy industry officials, developing effective ways to engage with the public is becoming more important. Most ongoing CCS perceptions research has emphasized "well designed" expert messages, i.e., messages that seek to convey information about the technology in a scientific but simple manner. The main goal is to target the general public and therefore to understand the factors that influence the public's attitudes toward the technology.[11−14] We have argued that the perceptions of EV citizens in the frontline states are different from those of the general public, and that these should be the focus of the next wave of CCS campaigns. We have also argued that emotionally self-referent messages are at least as important as expert informed messages if EV attitudes are to be influenced.

In this study we do not advocate either for or against the implementation of CCS. Rather, we suggest that social marketing

is a potentially powerful approach in engaging with the public about CCS, whatever be the intent of the engagement. Our application of social marketing methods to the energy domain contributes to an emerging set of studies investigating ways to communicate with the public about carbon management technologies. Our method of identifying citizen-guided ESR triggers, and campaigns based on these, could be useful to persuasive messaging in a wide range of domains, including energy policy, environmental policy, and public health. Finally, while we recognize that ESR triggers are place-based and specific, we believe that the methods we developed to elicit these triggers will hold with other EV citizens in states with significant fossil fuel operations.

■ ASSOCIATED CONTENT

Supporting Information. Descriptions of the ESR triggers and expert CCS messages, CCS campaign tool, and Gillette and Rock Springs, as well as additional subgroup analysis.This material is available free of charge via the Internet at http://pubs.acs.org.

■ AUTHOR INFORMATION

Corresponding Author

*Phone: (510) 642-1640; fax: (510) 642-1085; e-mail: gwong-parodi@lbl.gov; mail: Energy and Resources Group, University of California, Berkeley, 310 Barrows Hall, Berkeley, California 94720-3050.

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