Public Attitudes Towards Enhanced Geothermal Heating: The Role of Place, Community, and Visions of Energy Futures

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ABSTRACT

Understanding how the public assesses the risks, benefits, and tradeoffs of new energy projects, like enhanced geothermal systems (EGS), is crucial for successful project implementations. Public acceptance of EGS, particularly the evaluation of induced seismicity risks, can be a major barrier to EGS development. This study investigated residents' attitudes towards energy sources in Tompkins County, New York, using focus group discussions to illuminate how participants envision the future of energy in their community, the range of perspectives and values used to interpret different energy technologies like EGS, and the role of contextual variables such as place and community. We find that key factors shaping participants' judgments of the acceptability of EGS include trust, fairness, and the distribution of risks and benefits. Participants reported strong attachment to community and place, and their assessments of EGS acceptability drew on the compatibility, or lack thereof, between their interpretation of the technology and their sense of place. Reactions to EGS, including assessments of the risks and benefits, were also shaped by past experiences with energy projects and institutions and by how well EGS was perceived to fit with the overarching visions participants held for the future of energy in their community. This study sheds light on how contextual variables influence attitudes towards EGS, including the underlying role of community ties, place attachment, and local history in shaping support or opposition for new energy technologies, with implications for risk communication strategies that contribute to effective public engagement and equitable decision-making in efforts to develop low-carbon energy systems.

1. Introduction

Enhanced geothermal systems (EGS) are a form of geothermal heat extraction that relies on creating engineered reservoirs within low permeability rock layers. After an engineered or enhanced reservoir has been created, fluid is pumped into the system via an injection well, heated through contact with the rocks, and returned to the surface via a production well, where the hot water or steam is used for generating electricity or for heating. EGS allows the exploitation of geothermal heat throughout a broader geographic range than conventional hydrothermal systems by creating engineered reservoirs anywhere that sufficient temperatures can be reached through drilling (Tester et al., 2006).

Though EGS has been described as one of the most benign and low impact options for renewable energy, particularly in terms of visual impact and potential for baseload power (Stephens and Jiusto, 2010), it also carries the possibility of induced earthquakes, a major risk factor and source of potential disruption to nearby communities (e.g., Ellsworth, 2013; Porter et al., 2018; Trutnevyte and Ejderyan, 2018). While addressing the risks of EGS development requires significant technical considerations, the development process also requires a credible siting process involving active participation and engagement, with the recognition that "a technology's license to operate depends on public acceptance" (Hoşgör et al., 2013, p.1032).

While a small but growing body of literature has considered the public acceptance and risk communication challenges represented by EGS, little work has addressed how responses to EGS are shaped by the context in which EGS projects are embedded, especially the role of place and community. In this qualitative study, we use community focus group discussions in a county where an EGS project has been proposed to identify key factors that drive opposition and support, including how participants evaluate risks, benefits, and tradeoffs, and how they situate their interpretations of EGS within existing visions of the future of their community. In the following sections, we review literature on public acceptance of EGS and induced earthquakes and introduce the setting of the study.

1.1 Public Acceptance of EGS

In recent years, there have been calls for increased insights into the risks and social impacts of EGS (Pellizzone and Allansdottir, 2019; Trutnevyte and Ejderyan, 2018), particularly the possibility of induced seismic events, such as the 2006 Basel and 2017 Pohang earthquakes (Porter et al., 2018). Seismic risk plays a prominent role in public discourse about EGS; Dowd et al. (2011) found that, in a study of social acceptance in Australia, the key concerns expressed by the public were seismic activity and water usage. Examining news media framing of EGS in Switzerland, another study found that seismic risk was a key frame used in arguments opposing EGS (Stauffacher et al., 2015), while Knoblauch et al. (2019) compared attitudes towards different development scenarios and found that seismic risk affected acceptance most strongly.

Other key factors in attitudes towards EGS and induced seismicity involve the benefits involved, the fairness of their distribution, and the fairness of the development process. Investigating the acceptability of induced earthquakes, McComas et al. (2016) found that induced earthquakes, regardless of the form of technology causing them, were significantly less acceptable than natural earthquakes. Participants were also less likely to accept induced seismicity when private companies received the benefits of the technology, and when they believed that people like them did not have a voice in the process. Perspectives from other investigations of energy acceptance have also highlighted the importance of procedural fairness; perceptions of a fair process make it more likely that people will accept the outcome and view it as legitimate, even when it is not their favored outcome (Besley, 2010; Gross, 2007). Closely linked to perceptions of fairness in the development process is trust in the decision-makers undertaking a project, which is also central to public support and has been shown to influence perceptions of the risks and benefits (Huijts et al., 2012; Siegrist and Cvetkovich, 2000).

There is considerable uncertainty involved in EGS development, and the level of uncertainty that the public perceived is another factor that has been identified in shaping judgements of EGS. In an investigation of risk messaging about induced seismicity, statements of uncertainty and limited expert confidence increased participants' concerns about both geothermal energy and shale gas (Knoblauch et al., 2017). Another study of Australian media coverage found that economic feasibility and technological uncertainty were the most frequently reported concerns (Romanach et al., 2015).

These studies indicate that induced seismicity risks are central to EGS-related attitudes, and that the risks, benefits, fairness, trust, and uncertainties – both economic and technological – involved in a project play a role in how people judge acceptability. Beyond these characteristics of EGS, literature on energy acceptance also suggests that another key factor in public responses to energy technologies is the context in which they are embedded. Place theory has been used to explore the influence of emotional bonds to a place (place attachment) and the meanings attributed to a place on residents' reactions to local changes and disruptions brought on by energy developments. Place attachment can be a driver of opposition to land use changes, due to the perceived threat of disruption (Jacquet and Stedman, 2014); whether a technology is viewed as a potential threat is related to how consistent the symbolic interpretation of the technology is with symbolic meanings of place (Devine-Wright, 2009; McLachlan, 2009). This concept of "place-technology fit" proposes that opposition is driven by perceived contradictions between interpretations of place and technology. Besides the interaction of subjective interpretations of place and technology, also relevant is the interaction between perceptions of an individual energy technology like EGS and visions of energy futures in a community. The overarching visions and narratives held around energy transitions shape how development unfolds and the decisions that are made in choosing among alternatives (Sovacool, 2019).

1.2 EGS in Tompkins County, NY

This study focuses on attitudes towards EGS and energy transitions in Tompkins County, New York, a rural county in the Finger Lakes region of New York and home to the city of Ithaca, Ithaca College, and Cornell University's Ithaca campus. Cornell University is also the site of a proposed EGS installation, the Earth Source Heat (ESH) project, which would provide district heating to the campus. ESH was proposed in 2009 as a component of Cornell's Climate Action Plan and is currently in the preparatory phase of the project, having conducted seismic surveying and geological characterization ("Earth Source Heat" n.d.).

Attitudes towards potential energy projects are likely to be shaped by past experiences in the region, including a vigorous public debate over hydraulic fracturing in upstate New York prior to a state-wide moratorium in 2014 (Kaplan, 2014). Other prominent recent experiences include Lake Source Cooling, a project by Cornell University to use cold water from Cayuga Lake to cool Cornell and the local high school, which was met with opposition from a local group concerned about disruption to the lake, but completed in 2000, substantially decreasing Cornell's carbon footprint (Chaisson, 2009). In the village of Enfield, controversy over the proposed 16MW Black Oak Wind Farm extended for more than ten years, ultimately resulting in the cancellation of the project in 2017 ("Black Oak Wind Farm," n.d.; Crandall, 2017). The complexity of relationships between individuals, communities, governments, and institutions in Tompkins County, when it comes to decision-making around energy, is bound up in these and other prior experiences, which in some cases have generated lingering divisions and distrust that continue to shape responses to new energy projects.

The objective of this study is to assess participants' attitudes towards EGS, their evaluations and interpretations of the risks, benefits, and tradeoffs, and the values and perspectives that underpin participants' attitudes towards EGS and energy options. We aimed to identify key areas of agreement and contestation regarding desirable energy futures, and to illuminate how underlying variables of place, symbolic meanings, and visions for the local energy landscape shape judgments of the acceptability of an EGS project.

2. Methods

Five focus groups were held in the summer and fall of 2019 in locations throughout Tompkins County. We purposively recruited area residents who had previously been engaged in energy-related discussions and events by targeting community listservs and local organizations. This was done in order to facilitate in-depth, deliberative discussions with a segment of the population likely to be highly engaged in public discourse about energy issues. Pre-existing familiarity with other focus group participants can lead to greater interaction and participation, and more open sharing of personal experiences and opinions (Bloor et al., 2011; Stewart, 2011). In addition, as noted by Kitzinger (1994), using pre-existing groups allows researchers to explore how people form ideas and make decisions within the social context in which the participants actually operate. Recruitment was topic-blind regarding EGS, with recruitment materials referring to a discussion of energy transitions. A total of 42 participants were recruited; the sample consisted of predominantly white, liberal adults, and was 45% female, 55% male.

The focus groups followed a semi-structured format that began with a general discussion of how participants felt about community and place before raising the question of energy transitions. The energy discussion began with a free-thought exercise in which participants provided the first word that came to mind when prompted with a series of energy sources (geothermal, wind, solar, hydropower, coal, and natural gas), in order to evoke top-of-mind associations with each energy source. The responses to the exercise were used to prompt further discussion of participants' preferences for energy systems in Tompkins County. Finally, participants were provided with a one-page handout describing how EGS functions, its risks, and its uses, and after reading the handout were prompted for their reactions and responses to the technology. Each focus group lasted for approximately 1.5-2 hours and ranged in size from 6 to 11 people.

The aim of this approach was to locate public responses to EGS within the broader context of local history, experiences with energy technologies, and participants' visions for the future of their community and their energy options. By funneling down to EGS from broader perspectives, we avoid assessing participants' reactions to EGS in isolation, instead capturing how an EGS project may be interpreted as one potential option within a local energy landscape.

Data analysis consisted of thematic coding; session transcripts and focus group notes were categorized during an initial round of coding that drew on sensitizing concepts from the above literature while allowing additional themes to emerge from close reading. A second round of focused coding was used to combine and sort categories (Charmaz, 2002; Lofland and Lofland, 1995).

3. Findings

3.1 Definitions of Place and Community

The main associations that participants had when discussing the unique characteristics of Tompkins County were of scenic, natural beauty and rural character, and engaged communities with strong identities. Other characteristics included "creative and curious," and a sense of small-town or village connection. While many participants noted a strong sense of community and diversity, others also expressed the opposite, experiencing a lack of community in their neighborhood or town and isolation due to a lack of infrastructure. Many participants described the presence of social "bubbles" and sharp divides between segments of the population in the county as a whole and within smaller towns and villages, such as between long-time, multi-generational residents "with the streets named after them" and newer residents.

In all five focus groups, the central challenges and opportunities that participants identified for the area focused on land use and development, inequality, transportation and growth overall. While the rural nature of the area was often cited as one of the characteristics that participants most valued, discussions of changing land use in the county identified tensions between farming, housing, and energy projects, with concerns about reductions in agricultural acreage changing the rural character. A desire of "keeping farmland farmland" expressed by some was countered by acknowledged needs to address local housing shortages. Other concerns that were raised involved impacts from climate change, local vs. outside ownership, and balancing increased opportunities and growth with changes to local character.

3.2 Energy Transitions and Visions of the Future

The free-association exercise revealed that participants were largely negative towards fossil fuels and ambivalent or positive towards renewable energy sources. The top-of-mind associations for coal included "dirty," "black lung," and "obsolete," and though some participants described a more ambivalent response to natural gas as affordable or "not all bad," the primary associations were with global warming. Associations were most positive towards solar power, where the most common descriptors were "abundant," "best," and "clean." Despite the overall positive associations with renewable energy options, one of the most common responses for wind, geothermal, and hydropower was "limited." Even in the initial top-of-mind responses, participants recognized the tradeoffs and drawbacks of each energy source, such as the expense of geothermal, the variability of wind and solar, and the need for storage.

In the discussions, reactions to each energy source were closely linked to past experiences with similar projects, such as the Black Oak Wind Farm, which was cited as an example of the difficulties of implementing wind power, or personal experiences with residential solar or heat pumps. Historical precedents were also cited; positive representations of hydropower, for example, were linked to local history and the reliance on watermills for industry: "Most of the little towns, everybody had to be by a river or a waterfall."

When asked about how they pictured the future of energy in Tompkins County, participants envisioned a future energy system that centered on increased use of renewable energy sources, both as a response to climate change and as a pathway for developing local energy resources and self-sustainability. The discussions across each focus group expressed a preference for more decentralized, distributed approaches over large-scale, centralized projects, which were viewed as top-down implementations typically associated with ownership outside the community and a lack of accountability. Though a few participants raised the issue of scalability, the majority focused on microgeneration.

These visions of energy transitions included both new energy technologies and improvements to grid infrastructure and storage. Participants also emphasized a multi-faceted approach that used locally appropriate mixes of energy options to balance tradeoffs, rather than a preference for any one form of energy technology over the other; they imagined a future where “you can mix and match and make things work,” while also increasing the efficiency of the system through innovations and improvements to infrastructure.

The concerns that participants raised in discussing energy futures strongly reflected their overall concerns about challenges facing the community, particularly the footprint of energy projects impacting agricultural acreage and local rural character, the issues of equity and accessibility of renewable energy for low income residents, and a preference for locally-owned and community-based solutions. Concerns about agricultural land use changes and energy development were intertwined with concerns about climate change and growing impacts on farmers.

3.3 Reactions to EGS and the Cornell Earth Source Heat Project

Reactions to EGS as an energy option for Tompkins County were mixed. Participants frequently drew negative comparisons between EGS and hydraulic fracturing, with some using the comparison to frame strong opposition: “It’s just like fracking, it’s way beyond what should ever happen.” Despite being a renewable energy source, the nature of the drilling, stimulation, and production processes evoked connotations of extractive industries like mining and oil and gas production, which for a small number of participants also evoked a sense of exploitation or violence. Other comparisons were made to Cornell’s Lake Source Cooling Project and to residential geothermal heat pumps, which were viewed in a more neutral or positive light. The Lake Source Cooling project was associated with community benefits due to providing cooling to local schools as well as Cornell’s campus, but was also remembered by some as an example of a lack of open communication with stakeholders, raising concerns that this would happen again with an EGS project.

Participants were generally familiar with geothermal heat pumps, with several having heat pumps installed in their homes, but generally unfamiliar with the concept of EGS. Familiarity with heat pumps provided a positive frame of reference for geothermal energy utilization, but participants also expressed preferences for the small-scale, decentralized nature of heat pumps over EGS, which was seen by some as involving too great a depth of drilling. In other discussions, one participant joked about the possibility of awaking demons, while another made reference to disaster films. The potential for induced earthquakes was a source of fear and uncertainty, closely tied to concerns about trust and transparency in the development process. Trust in the university varied considerably and was central to the discussions of the Earth Source Heat project; a lack of trust in how the project would be managed and how much input the public would have enhanced participants’ perception of the potential for negative impacts. Perceived benefits of the technology included the limited visual impact at the surface and the contribution to climate goals.

Reactions often focused on the costs of EGS, both the high economic cost required to implement it and the opportunity costs of choosing EGS over other alternatives. Participants questioned whether EGS was the best choice of available options: “it does not seem worth it to me to take this risk…rather than using other technologies that are available that we know have fewer risks.” Others, however, raised the point of high risk, high reward with respect to innovation, again returning to the question of tradeoffs. As one participant stated, “We have to have some tradeoffs, there isn't a perfect energy system that we have that doesn't have some negative to it.”

3.4 Compatibility of EGS with Local Energy Visions

The mixed responses to EGS as a possible energy alternative reflected concerns about the compatibility of EGS with the meanings that participants attributed to their community and the visions that they had for their future. The need for trust, transparency, and equitable distribution of benefits to the community emerged as a significant component of what sort of energy future they saw as desirable. While many participants raised concerns that the benefits of an EGS installation for district heating would not be equitably distributed to the wider community, others responded positively to the technology based on the inherent necessity of locating it within the community it serves, in contrast to past experiences with energy infrastructure sited in marginalized or low-income communities deemed expendable. As one participant stated, “the nature of this technology is that you can’t just throw it in the poor neighborhood and have them suffer while everyone else benefits…it’s localized enough that it’s going to be under the people it serves.”

Support for EGS also varied with its perceived “fit” with the different place meanings that participants attributed to the area. Some participants viewed EGS as a large-scale, centralized form of technology that could add to a trend of densification in the city of Ithaca and pose a threat to their view of the area: “I really value this as a rural place, and this [EGS] is definitely very urban.” EGS was also viewed as a technology that would require top-down implementation by large institutions, contrary to a desire for more community-based solutions. Others, meanwhile, focused on the experimental nature of the ESH demonstration project and viewed it as consistent with the character of Ithaca and Cornell University as places of innovation, research, and curiosity, noting that if such a project were to be done anywhere, it would be there.

4. Discussion: EGS in Context

Subjective interpretations and connotations of EGS influenced how participants responded to the possibility of the ESH project. Fears of induced earthquakes, a perception of “drilling too deep,” and comparisons to disaster movies evoked a sense of dread from some participants; the element of dread – characterized by the involuntariness, catastrophic potential, fatal consequences, and inequitable distribution of a risk – has been shown in risk perception literature to be closely associated with heightened risk perception and desire for regulation and risk reduction (Slovic, 1987). Joking references to “demons” and disturbing the depths, and reactions to the extractive nature of EGS also reflect literature in Science and Technology Studies (STS) conceptualizing the underground as a site that the public primarily experiences through media, stories, and models (Kinchy et al., 2018). Underground activity lends itself to cultural associations and tropes of the “underworld,” which carries implications both for how the public responds to geothermal exploration and for rhetorical strategies that may be used by opponents of geothermal projects to promote their arguments.

The variations in support for EGS provide support for the concept of place-technology fit proposed by previous studies of renewable energy acceptance (Devine-Wright, 2009; McLachlan, 2009), with EGS interpreted as both consistent and inconsistent based on the alternative place meanings of untouched rural countryside vs. site of innovation and experimentation, leading to more positive or negative judgments. For those who viewed EGS as contradictory to local character, the threat that such a project poses to identity was linked to broader trends within the community about land use changes and tensions between agriculture, energy, housing, and development. Local experiences of energy technologies – both projects in recent memory and historical legacies – also acted as interpretive schema through which participants evaluated energy technologies, including how the ESH project might unfold in the future. The role of place meanings suggested here offers additional implications for messaging strategy, as Jacquet and Stedman (2014) noted; actors involved in development may deliberately use framing that emphasizes fit with local place meanings and identities.

Participants’ reactions to EGS drew on assessments of trustworthiness, fairness, and the risks and benefits of the project, but also reflected participants’ overall visions for energy futures. These preferences generally prioritized decentralized, distributed energy solutions, while also reinforcing the importance of equity and fairness in the development process as a determining factor in acceptability. Evaluations of the ESH project and its appropriateness for the area were not judged in isolation, but rather situated in the wider landscape of current and future energy alternatives and the tradeoffs associated with choosing ESH. For those who viewed ESH negatively, the expense involved in the ESH project was framed not only as a significant financial cost for the university but also as a missed opportunity for investments in other, less risky endeavors.

5. Conclusions

The findings of this study demonstrate that key factors shaping participants’ judgments of EGS include trust, fairness, and the distribution of risks and benefits. Participants’ interpretations of EGS were strongly influenced by their experiences with past energy technologies, most prominently hydraulic fracturing and Lake Source Cooling, which influenced perceptions of the potential impacts, as well as current levels of trust in institutions. Public perceptions of the risks of induced seismicity may be driven in part by associated characteristics of dread and narratives of the underground. Perceptions of place-technology fit also influenced support for EGS, which was viewed as both congruent and incongruent with different symbolic place meanings held by participants. In discussing EGS and the broader landscape of energy possibilities for Tompkins County, participants recognized the potential role of EGS as well as the tradeoffs and alternatives involved, with the acceptability of EGS positively influenced by perceived fit with envisioned energy futures.

By understanding the factors that inform how the public judges the acceptability of EGS, we can identify a fundamental process leading to support or opposition for such projects. This will lead to more effective strategies for communicating about EGS in ways that encourage systematic consideration of the benefits, risks, and tradeoffs, while taking into account the effects of varying contexts and social and cultural narratives that EGS evokes. This study forms the first stage of a larger project; future work will consist of additional case studies of EGS sites providing comparison to the ESH project and Tompkins County. The comparison of multiple cases will further illuminate the underlying processes that lead to support or opposition to EGS and contribute guidance for effective risk communication and public engagement.

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