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Moving From "Doing to" to "Doing With": Community Participation in Geoenergy Solutions for Net Zero—The Case of Minewater Geothermal

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Low carbon geoenergy technologies are anticipated to occupy a range of roles in the transition to a net zero carbon future, and there is growing acknowledgment and awareness of the importance of societal considerations and community participation in the development and implementation of such technologies. Here, we use the example of minewater geothermal to explore the potential to enhance societal benefits of energy transition developments. Minewater geothermal uses the water in abandoned and flooded coal mines to provide low carbon heating and cooling of homes and businesses and thermal energy storage. Many towns and cities worldwide have potential minewater geothermal resource, offering significant potential for technology scale up, and there are a number of projects in development and operation. We outline how such projects could occupy a role beyond technological implementation given factors including the local dimension of the resource, together with its links with a community's mining and cultural history, and social, political and environmental impacts of coal mine abandonment. We argue that working with communities to deliver these projects is paramount, and outline five key principles and recommendations for community participation to ensure a fair and sustainable net zero transition. While tailored to minewater geothermal projects, the nuances of these recommendations are relevant to other geoenergy developments.

Keywords: public participation, decision making, just transition, sustainable geoscience, local energy, public engagement

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INTRODUCTION

Low carbon geoenergy technologies are anticipated to play a role in meeting and living in a net zero future (Stephenson et al., 2019), and there is growing acknowledgment of the important roles of people and communities in energy systems change (Creutzig et al., 2022). Such roles include the societal acceptability of such technologies (Dickie et al., 2020; Demski, 2021), their adoption and implementation, as well as their fit within a "just transition" (Bidwell and Sovacool, 2023).[1] There

[1]A "just transition" is the concept that the burden of climate action should not be borne unequally by one set of workers or communities or any one country (Bray and Ford, 2021).

TABLE 1 | Summary of the three primary rationale for public participation, adapted from Dunphy et al. (2021) after Fiorino (1990) and Smith et al. (2005).

Argument	Rationale for public participation
Normative	The publics are a stakeholder, therefore public participation is the right thing to do
Substantive	The publics offer valuable perspectives, therefore public participation will lead to better quality decisions (i.e., outcomes)
Instrumental	Public participation can help to reach a given goal, through, for example, building support, raising awareness, building trust (i.e., process)

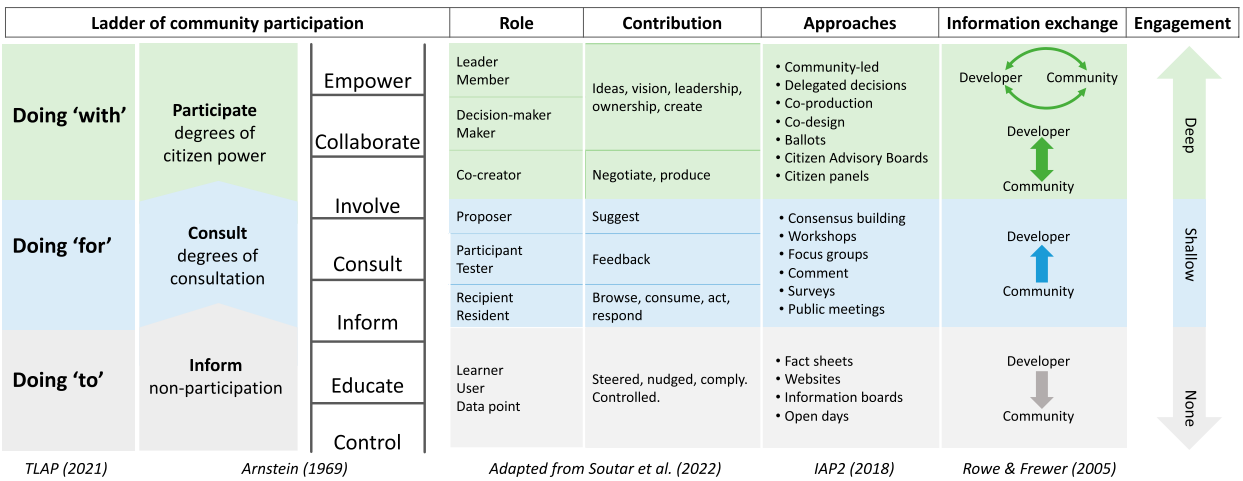

FIGURE 1 | Schematic "ladder" of community participation, adapted from Arnstein (1969), International Association for Public Participation (2018), Think Local Act Personal (TLAP) (2021), and Soutar et al. (2022). The Rowe and Frewer (2005) model of engagement, based on flow direction of information, is incorporated to the right of the figure, with engagement modes towards the very top rungs of the ladder characterised by information sharing and exchange.

are three key arguments for why community participation is important (**Table 1**). These include it i) being the right thing to do, ii) it being a better way to achieve particular ends (process), and iii) it leading to better ends (outcomes) (Smith et al., 2005). Community participation in climate action is not only mandated by the 1992 Rio Declaration (Principle 10), it is vital for societal acceptability and for projects to succeed (Wynne, 2006; Haggett, 2010) particularly for new or unfamiliar technologies (Walker et al., 2010a). "Energy democracy" is one framework for a just transition (Upham et al., 2022), centred as much on inclusive and fair *process* as much as fair *outcomes*. Regardless of the rationale, public engagement and participation can impact the pace, cost and success of net zero delivery (Demski, 2021; Creutzig et al., 2022).

The term public or community engagement is often used synonymously with public participation (Devine-Wright, 2011a), however the degree of influence or control over decision-making that is afforded through engagement—and therefore the degree of public participation—varies greatly (Pallett et al., 2019).

Different community engagement modes can occur when infrastructure projects are being planned and implemented, typically along a continuum line from one-way-only to fully two-way information exchanges, or between communication, consultation and participation (Rowe and Frewer, 2000; Rogers et al., 2012). Frequently referenced in this discourse is Arnstein's ladder of participation, first published over 50 years ago (Arnstein, 1969), which depicts varying degrees of citizen participation and associated power-sharing. The rungs of the "ladder" detail increasing levels of control that citizens can have over a situation, with "non-participation" towards the base of the ladder and citizen power at the top (See **Figure 1**). The normative understanding is that the higher levels of the ladder are more empowering and therefore more desirable to the base of the ladder.

The ladder has since been adapted to frame the concept of co-production, particularly with regards to public services (Think Local Act Personal, 2021), **Figure 1**. Rowe and Frewer (2005) prefer to classify public engagement into communication, consultation, and participation, based on the flow of information and influence of public views, and whereby public participation is defined by two-way information exchange. Citizen participation goes beyond information provision and consultation, it is a process that incorporates members of the public in decision-making and fully considers this public input in decisions.

Traditional forms of planning consultation are widely understood by political science and community engagement best practice literature to be non-inclusive, model one-way, linear information exchange, and lean towards information deficit models of public acceptance (Cohen et al., 2014) and the 'inform' or 'do to' level of the community participation spectrum (**Figure 1**). Despite wide recognition that these are

inadequate, there is little evidence of the application of deeper, cyclic or iterative levels of participation in planning consultations and other decision-making processes (Pallett et al., 2019). Across multiple applications, societal engagement is still considered a hindrance and a nuisance (Moreira et al., 2022), there are tensions and structural barriers (Pallett et al., 2019; Skjølsvold and Coenen, 2021; Wahlund and Palm, 2022), and declared commitment to community participation and engagement does not always reflect the reality on the ground (Moreira et al., 2022). Thus there are few examples of community participation being embedded within decision making processes including project design (Pallett et al., 2019; Soutar et al., 2022), and little policy commitment to support community-led initiatives for geoenergy solutions (Chavot et al., 2018).

If this remains the *status quo*, the wide range of benefits that low carbon geoenergy solutions could bring will not be realised, limiting the potential for such projects to meet wider sustainability principles and hindering social and environmental benefit from the net zero transition. Further, without embedding community within the design of geoenergy projects, there is a risk that uptake or implementation of low carbon geoenergy projects will remain slow.

In this perspective, we use the case of minewater geothermal energy (MWGE) to outline how community integration—by which we mean two-way dialogue, power sharing in decision-making, and considering fit to place, context, and wider community priorities—is important for emerging geoenergy applications, for technology uptake and adoption, and social and environmental justice. It serves as a call to action to take a wider view of geoscience and engineering projects, to better resource community engagement and to move towards increased citizen power and empowerment for a just transition (i.e., higher up the "ladder" of community participation, **Figure 1**).

We first start with an overview of MWGE and why we consider it to be a good example technology for understanding the benefit and importance of community and place context for geoenergy development. We then lay out five principles for community participation for MWGE projects, drawing on learning from a wealth of literature and practice from energy and public participation case studies and best practice. These key considerations must be recognised if MWGE is delivered at pace and scale and commensurate with delivering a prosperous, inclusive and equitable net-zero transition. We translate these lessons into recommendations to embed social considerations within future geoenergy developments.

MINEWATER GEOTHERMAL ENERGY (MWGE) AND ITS POTENTIAL TO DECARBONISE HEAT

Geothermal energy is the heat energy contained in the Earth's subsurface. Its use, whether for heating and cooling or for power generation is well-established worldwide (Gluyas et al., 2018). There are different approaches for harnessing geothermal energy, depending on geological conditions and other factors. Minewater geothermal technology uses the water in abandoned, flooded coal mines for heating, cooling or thermal storage. For minewater geothermal heating, heat exchangers, heat pumps and hydraulic pumps powered by electricity are used to recover and distribute the thermal energy and carrier fluids to buildings *via* heating networks. If sustainably managed these systems could provide a continuous supply of heat.

Many of the towns and cities in the UK and across Europe are areas of former coal mining activity and the shallow flooded mine workings are prospective to heat local homes and businesses (Walls et al., 2021). Projects worldwide have demonstrated mine water heating, cooling and inter-seasonal storage (Walls et al., 2021) and widespread scale up is anticipated (Watson et al., 2019; Monaghan et al., 2022).

MWGE provides a particularly interesting and topical example for several reasons.

- While MWGE is an emerging technology, global resource estimates are large (Monaghan et al., 2022). There is particular interest in minewater geothermal in the UK and Europe as a pathway to accelerate heat decarbonisation: there is significant potential for MWGE projects to provide low carbon heat to homes and businesses local to the resource (Watson et al., 2019; Abesser and Walker, 2022). The local dimension to the resource, and connection with district heating gives a community-centric lens.
- Potential MWGE resources are, by default, located in former coal mining areas which, in the UK, are disproportionately deprived or low-income (Shirani et al., 2021). The social justice implications of decision making are particularly important given the environmental, health, and economic inequalities in coalfield communities (Alessandra and Roberto, 2022), strong associations with fuel poverty, and sensitive political and power narratives (Gibbs, 2018; Abreu and Jones, 2021.)
- At present, awareness of geothermal technologies is generally low among the publics (Pellizzone et al., 2017; BEIS Department for Business and Energy and Industrial Strategy, 2020; Dickie et al., 2020) and supply chains (Abesser and Walker, 2022) and there is little to no research on social engagement, public perception, preferences or priorities for MWGE (Abesser and Walker, 2022).
- The technical risks of MWGE are site specific and in some cases not yet fully understood. In such cases, as shown in previous emergent stages of innovative energy generation, concepts of transparency, justice, and (dis) benefits distribution are key (Mendonça et al., 2009; Carr-Cornish and Romanach, 2012).
- MWGE offers an opportunity for wide-reaching financial, health, cultural and environmental benefits to communities (Pramangioulis et al., 2019; Bianco et al., 2021) as well as meet the priorities of local and subnational stakeholders (Abesser and Walker, 2022).

- Energy decarbonisation is not just about installing and operating new technologies (Soutar et al., 2022), and despite the potential benefits MWGE schemes could bring, there could be negative connotations and consequences if community stakeholders are not effectively engaged (Wahlund and Palm., 2022). As such, effective engagement needs to consider local values, cultural heritage, sensitivities and strengths (Seyfang et al., 2014).

Thus, there is much to gain through community involvement for integration within the design of MWGE initiatives, and, similarly, much at stake. These key lessons or principles for community involvement may be tailored to MWGE but they are relevant to other geoenergy applications, too.

FIVE KEY PRINCIPLES FOR COMMUNITY PARTICIPATION IN MWGE PROJECTS

Local Energy Projects Reach far Beyond Energy

Implementing innovative energy infrastructures and gaining community acceptability is not simply related to attributes of the proposed technology or infrastructure (Chavot et al., 2019); instead, projects and developments are contextualised by a community's past energy related experiences (Cuppen et al., 2020), alongside wider social, political, or cultural issues (Soutar et al., 2022) that may not be related to energy. Further, the implementation of localised energy systems can change social and cultural aspects of energy generation and consumption across varying areas of society (Batel and Devine-Wright, 2015).

This might be particularly the case for MWGE given the role that mining often has in a community's cultural and social identity. As such, MWGE could occupy a much wider role than solely technological implementation.

Relating to this, energy projects with a community or local dimension are associated with wider benefits such as building local citizenship and social and economic capital, and skills (Hogan et al., 2022). Thus, MWGE projects are not purely about energy, and community interactions and acceptability are not solely constrained to the developers or the project.

Although the central aim of new energy infrastructure strategies such as MWGE may be to reduce emissions, these projects and their constituent processes have been shown to have consequences or co-benefits that can be more impactful than simply reducing greenhouse gas emissions alone. In the context of a wider energy transition (i.e., the pursuit of social, economic and environmental pathways to a more sustainable future; Ürge-Vorsatz et al., 2014), these co-benefits include areas of human health, ecosystem performance, social equity, and economic shifts. These consequences form an important aspect of decision-making, and evaluations of outcomes (Hamilton and Akbar, 2010). However, the complex nature of these co-benefits and the possibility for consequences to be interconnected with multiple others, together with varying perspectives amongst stakeholders depending on their personal intentions, experiences and objectives (Floater et al., 2016; Sovacool, et al., 2020), means there is potential to simplify, mask, or overlook some consequences. These complexities must be considered when identifying, measuring, prioritising, and communicating benefits of schemes such as MWGE to the public, communities and other stakeholders, thereby enabling effective navigation of MWGE implementation to achieve maximal benefits.

Connect MWGE With Place, Heritage, Pride—But do so With Sensitivity

The framing of energy technologies is important for community acceptability (Dickie et al., 2020) and should be tailored to place. In the case of MWGE, such place-based frames will likely connect with mining heritage, clean environment, reduced fuel poverty and social cohesion but must be considered with care and sensitivity.

Many former mining villages and towns retain a strong and sensitive connection to their mining heritage (Rohse et al., 2020). Local residents have not forgotten the built environment of the abandoned mining industry and its political history (Gibbs, 2018). Coalfield communities may have significant community pride built from close-knit, hardworking mining culture, with mining being a once thriving industry providing prosperity and employment, together with hardship and sorrow (Llewellyn et al., 2019). Those who live in former mining communities may be acutely aware of risks relating to subsurface mines and suffering associated to its mining past and will live with the environmental degradation and disadvantaged socio-economic conditions caused by mine closure. This mixture of meanings and values associated with mining, and its heritage and impact on a place, is a key consideration when engaging with local communities and stakeholders, as it will shape their appetite, perceptions, and expectations of MWGE (Thomas et al., 2022).

Care should be taken not to glorify mining history, or underestimate its links with the present. More generally, it is important to understand where MWGE fits within community priorities and local development plans so as to develop place-appropriate frames. Language such as 'regeneration' can be insensitive (Chaffin and Evans, 2017), as is the assumption that people living in economically deprived areas will support developments that promise to reduce energy bills. For appropriate and effective engagement, nuanced links to place, past, and future need to be acknowledged and carefully navigated. This is a path best led by the community who "own" this history and its connected future, both for reasons of recognition and restorative justice.

Prioritise Equity Within MWGE Projects

Ex-mining heritage is now synonymous with issues of environmental degradation and disproportionate deprivation (Beatty et al., 2019; Abreu and Jones, 2021). Similar is said of

areas with deep geothermal energy potential, following the demise of metal mining associated with geothermal processes (Abesser and Walker, 2022). In such areas, issues of equity are particularly stark. By producing affordable heat, MWGE offers routes to reduce fuel poverty (Gillespie et al., 2013), but also to invigorate local prosperity and new or reimagined place-based narratives, as well as create local employment (Mine Energy Taskforce, 2021). MWGE projects integrated within these communities could also break down the perception of energy transition as an undertaking primarily by the privileged.

Equity must be embedded in the process design, and from the community perspective, not in promise but in practice, and in terms of process as well as outcomes. There are examples of geoenergy associated projects that have claimed a focus on equity, for example, in terms of creating jobs within a deprived locality and supporting climate action, while contemporaneously removing the only green space available to that community (Scottish Parliament, 2021). At this early stage of technology adoption, if similar was done for a MWGE project, it would put other future MWGE projects at risk.

Ensure Early, Sustained and Transparent Dialogue to Support Local Prosperity

It is now well established that building and maintaining trust is key to effective community engagement and participation (Walker et al., 2010b). Trust is supported by dialogue (two-way flow of information, Rowe and Frewer, 2005; **Figure 1B**), and through power-sharing, allowing community and local stakeholders to participate in decision-making and planning (Wolsink, 2007; Walker et al., 2010a; Goedkoop and Devine-Wright, 2016). In fact, research finds that perceived fairness and transparency in project planning, implementation, decision making, and outcomes not only supports societal acceptability, but can even overcome the presence of negative impacts (Gross, 2007). Although deep geothermal, not MWGE, the success of projects in the city of Munich is largely credited to early engagement with involved communities alongside extensive public engagement, starting 3–4 years prior to drilling (Abesser and Walker, 2022). There is no one approach of enabling such dialogue; appropriate approaches will be tailored to place, and may involve multiple forms of participation (Pallett et al., 2019). Such engagement requires time—raising an apparent paradox regarding time investment for dialogue and participation to enable rapid energy transition (Skjølsvold and Coenen, 2021; Wahlund and Palm, 2022). Further, participation can identify sometimes multiple different values and visions of future systems change that can contrast with technocratic perspectives (Pallett et al., 2019; Skjølsvold and Coenen, 2021) and bring insight into future social worlds. Rather than defending the technocratic view, respecting these differences (i.e., listening and responding dialogically) in shaping outcomes is key, both for substantive and instrumental reasons (**Table 1**). Put differently, organisations must respect community perspectives both in terms of whether or how a project is decided, implemented or rejected.

Early sustained and transparent dialogue is particularly important for MWGE because there is currently little to no research on social engagement and public perceptions of the technology, and little widespread understanding of what the technology means for households, businesses, and communities. Engagement therefore needs to offer routes for communities and other stakeholders to have a forum for communication and dialogue to support information giving and sharing and narrative building. This includes open dialogue on what to expect in terms of timelines and potential disruption as well as, e.g., whether and how communities can have a say, and technical aspects such as uncertainties, risks, and responsibilities. Importantly, these routes must allow community to influence without unnecessary or additional burden.

Effective dialogue and community involvement can also support social capital, for example, increasing the sense of place, or boosting individual's ambition, self-worth (Shane and Venkataraman, 2000) and self-efficacy (Roberts and Escobar, 2015). Importantly, care should be taken to ensure that community groups are not co-opted by developers to provide social capital to potential projects (Lennon et al., 2019); there is a thin and delicate line between acknowledging and taking community place relationships into account, and exploiting them for the benefit of a project.

Take a Whole Systems, Inclusive and Responsive Approach to Community Engagement

Due to MWGE potentially having wide reaching societal, cultural, political, economic and environmental outcomes, it's important to adopt a whole systems approach to best pinpoint the interactions between process and outcomes (Sovacool et al., 2019; Sovacool et al., 2020). This route makes sure that synergies and critical components are not overlooked, and components that can alter the way in which the (multiple different) properties of the implemented system are seen (Anarow et al., 2003). This is particularly important when considering that barriers to uptake or development of new technologies are frequently described as being confined to lower-level collective decision-making units, and therefore personal and social factors play a significant role in enabling an energy transition (Biresselioglu et al., 2020).

In contrast to strategies that focus on lifecycle impact or supply chain interactions, this whole systems approach broadens its focus to cover not only cost and carbon, but also elements such as social sustainability, security and justice (Sovacool et al., 2020). This means both the entire life cycle of a project and also the wider context and environment can be considered during decision making (McLaren, 2012). Resultantly, to best engage and generate participation a broader range of key performance indicators (KPIs) need to be understood. These indicators need to break away from the relatively closed loop of innovation and technical change, and instead offer insight into the cultural and social contexts, producing a pathway to embed energy infrastructure projects in a place (Bridge et al., 2018).

This embedded nature is also important to consider in relation to ensuring a just energy transition, as there is the need to measure and assess the costs, benefits and processes involved in decision making (Sovacool and Dworkin, 2015), thereby determining if any groups are excluded or are benefitting disproportionately (Healy and Barry, 2017). Consequently, there is an energy justice focus necessary to provide insight into the ethical aspects of a project, in addition to the technical, environmental, political and cultural ones, which could indicate the parties who may "win" or "lose" from a project (Bridge et al., 2018). This is particularly important to consider when working in communities who, while rich in cultural heritage and place-based identity, have in preceding decades been disproportionally disadvantaged by environmental degradation. Put simply, a MWGE project should not go ahead on the grounds of being technically and economically feasible; wider sustainability considerations, including environmental and social factors must be carefully weighed up.

INCORPORATING THESE PRINCIPLES INTO FUTURE GEOENERGY DEVELOPMENTS

We have drawn on a wealth of research and practice literature to distil five key principles for community participation in MWGE projects worldwide. These five principles for community involvement around geoenergy projects such as MWGE highlight how interaction and dialogue are required with project stakeholders and community, to not only ensure the successful implementation of a scheme, but to also achieve a wider range of benefits that positively impact beyond simply providing or enabling low-carbon energy. The site-specific nature of MWGE projects and their link to heritage and culture lend these applications particularly suitable for community participation. Put simply, such dialogue will maximise successful outcomes and minimise project risks.

Recommendations for Future Projects

Building on these five principles, we recommend the following actions to generate routes for community participation in MWGE projects to support sustainable inclusive energy transition. These key lessons or principles for community involvement may be tailored to MWGE but they are relevant to other geoenergy applications, too.

1. Follow best practice guidelines such as the National Standards for Community Engagement (SCDC, 2016) to ensure, for example,: the rationale for community participation is carefully considered, (**Table 1**); stakeholder mapping is undertaken at early stage, adopting a wide scope as to possible vested interest individuals and groups; a variety of engagement approaches are adopted to promote multiple routes in which stakeholders can enter into dialogue, and enable different stakeholders to engage through appropriate and fair decision-making channels.
2. Research the current, recent and more distant local history and experiences of past industries and activities, focusing on the social and cultural stamps these experiences have left on the community, so as to ensure projects acknowledge or re-address past harm (e.g., resulting from past mine closures), learns from what works, and build or strengthen new positive narratives.
3. Examine how a project may benefit or disadvantage differing stakeholder groups using a wide lens.
4. Promote partnerships with communities to support and develop social capital, and to provide a platform to foster wider community benefits. These partnerships will be place, community, and development specific, and care must be taken to ensure that social capital and societal benefit are not exploited for the benefit of a project.
5. Identify and report on KPIs across a variety of measurables connected to the project, including social, environmental and economic variables, across a project's lifecycle.
6. Finally, to enable these actions, organisations must build the capacity of project staff and social practitioners (Moreira et al., 2022).

Betterment of the community, rather than success of a project, should underpin the approach. Thus, cutting across these recommendations is the requirement for organisations to respect community perspectives regarding whether and how a project is decided, shaped, and implemented. This includes respecting community decision to reject a project, should they deem projects not to align with their conceptualisations of place or visions and aspirations for the future.

There is potential for MWGE to unlock a range of different values and co-benefits. These values will be resource, place and context specific, and therefore whether those values are unlocked will depend on that context and the approach adopted. A priority for research and practice is to understand this further, and share insights, learnings, and innovation. Developing MWGE through approaches that embody just transition principles and support strong place relationships could provide transferable lessons to the wider geothermal and geoenergy sector at different scales and contexts.

Towards Increased MWGE Community Empowerment

Experience from other energy developments find that local prosperity is maximised through community ownership or local governance models. Such projects produce cooperative initiatives, or entrepreneurial commercial start-ups and cluster growth within communities, and energy innovation can attract wider businesses (Shane and Venkataraman, 2000; Tanimoto, 2012). These initiatives can trigger the growth of economic, ecological or socially motivated schemes, which can use social capital to positively develop local communities in different ways (Rennings, 2000; Seyfang and Smith, 2007; Devine-Wright, 2011b; Howells and Bessant, 2012). Community-led initiatives also support place-identity, social cohesion and community resilience (Jarvis, 2015), thus unlocking multiple forms of value.

While there are currently no examples of community-initiated or governed MWGE, the socio-spatial context of MWGE projects impacts the route to possible place-based prosperity, as it requires oversight of social relationships, communications and interactions and behaviours and routines, all of which are important when shaping an innovative energy infrastructure for an area (Stroper, 2000).

Thus, it is unlikely that there will a "one size fits all" model for community ownership of MWGE. The support required for such initiatives need to be tailored to that socio-spatial context and other place factors. Knowledge and experience sharing between different modes of community influence, governance or ownership of MWGE will be important for enabling diverse developments. These developments in turn could assist in accelerating wider community co-benefits and support other community priorities.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this perspective article as no new data were created or analysed in this study.

AUTHOR CONTRIBUTIONS

JJR: Conceptualization, investigation, writing and reviewing, visualisation, and supervision. LG: Investigation, writing and reviewing. RF: Conceptualization, investigation, reviewing, and supervision. JD: Writing and reviewing.

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CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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