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Stakeholder Engagement: A Supercritical Geothermal Example

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1. ABSTRACT

Supercritical geothermal energy developments have a challenge: when time horizons are long and uncertainties are numerous, how do we communicate value, engage investors and industry, and influence government policies?

There is great urgency, globally and nationally, in how to transition to low-carbon energy options, and current-day decision-making will dictate our energy and environmental future. Yet, large geothermal energy development projects are characterised by significant upfront investment and long lead times—from years to decades. Tapping into deeper supercritical systems to access significant higher temperature (400°C – 600°C) geothermal energy is not a new idea, but despite world-wide engineering efforts, present levels of technical understanding are limited to offer industry-ready solutions. Additionally, New Zealand's societal, regulatory, financial and market frameworks are not yet designed, nor aligned, to enable and accelerate supercritical geothermal development.

This paper outlines a supercritical geothermal research programme's approach to stakeholder engagement and communication, and shares some lessons learned in three key elements in the engagement approach:

i. *Māori-first Engagement*: interweaving knowledge systems and a multigenerational approach to resource management

ii. *Strategic Partnering*: involving others to expand the impact for, and beyond, the science activities

iii. *Authentic Communication*: curating information, and being open and honest about the unknowns

1. INTRODUCTION

This paper explores, using supercritical geothermal development as example, ways to engage with stakeholders and effectively communicate research, aiming to secure and maintain stakeholder interest when time horizons are long and technology success is uncertain.

1.1. Geothermal: Decarbonising Aotearoa New Zealand

Aotearoa New Zealand is transitioning to a low-emissions, climate resilient economy (CCC, 2012; MFE, 2022). The Climate Change Response (Zero Carbon) Amendment Act (NZ Government, 2019) supports New Zealand's contribution to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5°C above pre-industrial levels, and allows New Zealand to prepare for, and adapt to, the effects of climate change. The Act limits the use of offshore mitigation in emissions budgets, and as a result there is an urgent need to maximise domestic decarbonisation efforts.

A large increase in renewable energy use will be enabled by a decarbonisation of the transport sector, coupled with more development of renewable electricity generation, increasing efficiency in industrial process heat (thus reducing the consumption of fossil fuels) and transitioning industry to lower carbon energy. Geothermal energy offers Aotearoa a proven, indigenous renewable resource, with capacity to supply much greater levels of primary energy and green electricity. Geothermal energy can offer significant benefits in cost, carbon footprint, surface footprint and energy security, which makes it appealing for industrial and commercial businesses.

1.2. Future Geothermal Innovation & Time Horizons

If we consider Aotearoa New Zealand's existing geothermal investment landscape as a portfolio of innovation, it showcases a range of proven resource uses (e.g. 30-350°C, to ~3.5 km depth), technologies (e.g. wet steam technology, binary cycle plants, clean steam production) and applications (e.g. electricity generation, industrial scale direct use, balneology). While there are many aspirations for increased geothermal use (e.g. Climo *et al.*, 2022), there is no current national energy strategy, no sector-wide geothermal strategy, and no coordinated renewable energy resources strategy to provide a roadmap to guide, or appropriately balance, short-term and long-term opportunities. Effective long term strategic planning must look beyond known technologies and short-term results, and into uncertainty (for greater gains). Supercritical geothermal (>5 km, >400°C) is one such new, long-term venture that could offer significantly more energy than conventional geothermal fluids found at current depths (~3.5 km) and reservoir temperatures (<350°C).

One way to look at a growth strategy for New Zealand's geothermal future is using a horizon model (Figure 1). This model has been proposed "to help work with uncertain futures in imaginative ways, while also retaining important societal features from the present" (Sharpe *et al.*, 2016). This framework is relevant for investment in supercritical geothermal as it focusses on transformation (i.e. creating significant systemic changes), rather than resilience (i.e. adapting to retain current functions and processes).

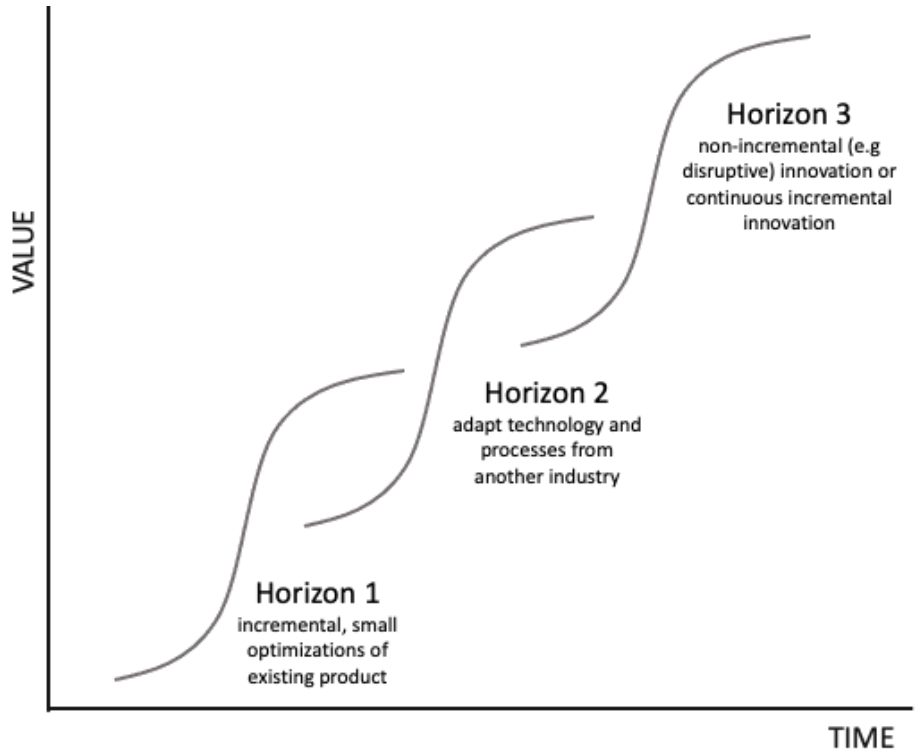

Figure 1: Mapping overlapping waves of technological innovation and change based on the three horizons model (Sharpe *et al.*, 2016). S-curves of innovation can represent product performance, competitive advantage, or generated value over time (redrawn from de la Kethulle de Ryhove, 2022)

Table 1 provides some examples of future geothermal innovations for Aotearoa New Zealand's energy sector, grouped by time horizon. Understanding this horizon framework, and see why long-term innovation takes time, helps to clarify why less certain projects, like supercritical geothermal, are worth the investment (and risk).

Table 1: Examples of Aotearoa New Zealand's potential future geothermal innovations, mapped to time horizons.

	Horizon 1 **SHORT-TERM**	**Horizon 2** **MEDIUM-TERM**	**Horizon 3** **LONG-TERM**
Description	Tangible results are within sight. Incremental, small optimizations of existing products.	Copied from adjacent markets/industries. Adapt technology and processes to a new context.	Long-term innovation projects. Non-incremental (e.g. disruptive) innovations, or continuous incremental innovation.
Application to future geothermal energy development in Aotearoa New Zealand:			
Timing	1-5 years	5-15 years	15-20+ years
Example Activities & Innovations	• Ongoing improvements in steamfield management • Extension of existing brownfield operations • CO_2 emissions reduction • Geothermal mineral production (e.g. silica, lithium) • Increased direct use applications	• Drilling deeper wells • Well design for hotter, supercritical fluids • Implementation of CO_2 reinjection and/or sequestration technologies • Enabling regulatory regimes • Novel investment models • Geothermal hydrogen productions	• Greenfield developments • Handling and use of supercritical fluids • Geothermal as a peak load supply

1.3. Stakeholder Engagement & Time Horizons

We define engagement as meaningful interaction with stakeholders, while communication is a one-way push of information (and a key delivery mechanism to support effective engagement). Together, stakeholder engagement and communication is a process of interpreting or translating information for different audiences. At its core, such engagement is about decision making — influencing a policy audience, engaging a practice (industry) audience, and/or communicating with the public. Projects with shorter time horizons are easier to engage with, and communicate, due to close alignment with user needs. Often short-term projects address a specific

problem, and tangible results are within sight. Conversely, long-term projects, with inherent uncertainty, can be much harder to secure stakeholder interest, and to maintain momentum over the long-term. The uncertainty and long-term nature of supercritical geothermal is a barrier in a time of critical decision making about reducing the impacts of climate change, and selecting where and how to invest in future energy options.

Engaging with the public and/or diverse stakeholders is rarely incentivised in the academic research system, however recent drivers to demonstrate impact (from research) has promoted increased stakeholder engagement. Despite recognised issues associated with individual performance awards, researchers are still rewarded for professional academic publications or successful grants (Belluz *et al.*, 2016), which require peer review and no prior publication of the results and ideas elsewhere. Sharing preliminary findings, thinking, incomplete data or failures is rarely done (so as not to face criticism and undermine trust in the research; Lutz, 2012), but this makes for a long lag-time between the research and the sharing of it. Research and researchers, as well as academic, patenting and publishing processes, typically operate on much slower and longer timelines than is the pace of modern media and communication (Lutz, 2012).

Often real world solutions require decisions and ongoing iteration — the need to make decisions and keep moving will refine the findings and keep the research moving in the right direction. Decarbonisation is a long-term transition, yet policy and investment decisions must be made in the short and medium term. Markman (2018) explored factors that make it hard for people to get motivated to act on climate change — a complex, long-term problem. These include:

- abstract concepts don't motivate people to act as forcefully as specific ones do;
- people overvalue benefits in the short term relative to benefits in the long term; and
- people value the present more strongly because the future is always more uncertain than the present.

These attributes could equally be applied to supercritical geothermal developments. Like climate change, supercritical geothermal is a long-term prospect, with lots of uncertainty, whose benefits/impacts are not yet reliably quantifiable. Added to this, solar, hydro and wind energy (also a part of Aotearoa's low-carbon, renewable energy options) are easier to understand than the more technical geothermal energy. Supercritical (and even geothermal) is an abstract concept for many people.

Effective engagement around supercritical geothermal, relies on there being a strong platform of familiarity and trust in geothermal energy and its advantages. Recently in Aotearoa New Zealand, geothermal energy found itself in a position of being thought of as a twilight industry (and one that is carbon producing). This misperception was evident in the Climate Change Commission's initial draft advice to Government. The New Zealand Geothermal Association's submission (NZGA, 2021a) successfully rectified this misconception, and the final advice to Government (CCC, 2021) positioned geothermal as a viable, low-carbon opportunity for Aotearoa New Zealand. This experience highlighted the importance of having ongoing and coordinated engagement and communication effort from the geothermal industry, and its allies, for geothermal to be considered as a top-of-mind low-carbon energy option. Added to misconceptions about carbon footprint, geothermal can also be at a disadvantage because, unlike other renewables, geothermal has long lead times, and financing an exploration and development programme is capital intensive and involves a high degree of risk. The significant and transformational benefits that come with geothermal developments, because not communicated widely or in a public friendly manner, are not well understood. Whilst those in the industry know that geothermal is a superior technology offering with respect to quadruple bottom line benefits; a framework to evaluate performance across four pillars: cultural, economic, environmental and social.

2. ENGAGING WITH A SUPERCRITICAL FUTURE

2.1. Geothermal: The Next Generation Research Programme

Aotearoa's central North Island hosts more than twenty world-class high temperature geothermal systems, making it one of the globally rare places where geothermal development is economically viable and technically feasible. Massive magma resources at temperatures above 750ºC support the broader volcanic belt at relatively shallow depths in parts of Aotearoa New Zealand, and this provides the energy that is contained in rocks at supercritical temperatures (Chambefort *et al.*, 2017).

Geothermal: The Next Generation (GNG; Chambefort *et al.*, 2019; GNS Science, 2020) is a New Zealand Government-funded research programme (2019-2024) established to explore and understand Aotearoa's supercritical geothermal resources, by going hotter and deeper into the Earth than we have drilled before (>4 km, >400°C). The reward? Significantly greater energy from an indigenous, renewable energy source.

The journey to a supercritical Aotearoa New Zealand is a long one — it will be decades before supercritical geothermal energy is business-as-usual technology. 'The Next Generation' refers to the need to look forward and build the next generation of scientists, decision-makers, research methods and innovative technologies. This research programme was initiated to start filling gaps in information, insights and ability to find, access and utilise supercritical geothermal energy in preparation for an exploratory drilling phase.

The long lead times means we have a chance to do things differently, in our stakeholder engagement, research design and interweaving of knowledge systems. Our goal is to deploy the skills and talents of our science team, leverage an existing knowledge base and our connections to others around the world, and offer a real and culturally-aligned option to decarbonise. We seized the opportunity to build a new brand (Figures 2 and 3), which would rejuvenate and modernise geothermal research, stakeholder engagement and science communication — making supercritical accessible, understandable and inspirational.

Figure 2: *Geothermal: The Next Generation*'s visual identity and logo.

Figure 3: *Geothermal: The Next Generation*'s brand identity.

2.2. Supercritical Stakeholders

To realise the aspiration of utilising supercritical geothermal energy it's going to take more than science. We need to connect our science with investors and planners, engineers and lawyers, resource owners and communities. Our five distinct stakeholder groups (Table 2) have varying levels of understanding about geothermal resources, interest in supercritical geothermal energy, and ability to influence the research programme and long-term goals of the project.

Table 2: Stakeholder groups identified by the *Geothermal: The Next Generation* research programme.

	POTENTIAL INVESTORS	GOVERNANCE & REGULATION	SCIENCE EXCELLENCE	ALLIES & ADVOCATES	COMMUNITY AWARENESS
IDENTITY DESCRIPTION	Entities established in, and familiar with, large-scale geothermal energy developments, including geothermal operators (national and international), Māori organisations with developed geothermal resources, and energy market teams in central government.	Staff in government agencies with responsibility for enabling and regulating natural geothermal resource use, energy efficiency, decarbonisation and environmental management.	National and international researchers and technical experts (e.g. scientists, drillers, operators and engineers) in geothermal programs and related sectors.	Staff from local economic development agencies, consultancies and subject specialists (e.g. finance, planning), as well as members of national and international professional associations.	Individuals, businesses and entities with a low level of familiarity with geothermal energy, including interested 'general public', Māori, educators, as well as media and science communicators.
DESIRED OUTCOME	Potential investors understand the value of the supercritical geothermal energy opportunity and have confidence in the developing business case for future supercritical developments.	Policy-makers and regulators act to ensure planning and governance frameworks are enabling for the sustainable development of Aotearoa New Zealand's supercritical energy resources.	The national and international geothermal research community holds our geothermal and supercritical research capabilities in high regard and want to collaborate with us.	Supportive allies champion and support geothermal development within their own sectors and networks.	An enhanced understanding of geothermal energy leads to social license for ongoing supercritical research, industry drilling and supercritical development in Aotearoa New Zealand (long term).

Three examples of our approach to engagement with these stakeholder groups are detailed in the following sections: 1: Māori-first Engagement; 2: Strategic Partnering; and 3. Authentic Communication. It should be noted that it is not the intention of the project to 'convince' or 'sell' supercritical geothermal developments, rather the aim is to provide insight and information to support informed decision making and a greater understanding of the potential benefits and risks associated with these endeavours.

3. MĀORI-FIRST ENGAGEMENT

Our future is embedded in the energy of our people and our environment. We are taking a Māori-first approach to engagement, recognising that Māori will be highly influential in the realisation of Aotearoa New Zealand's supercritical geothermal projects. As landowners, investors and kaitiaki (guardians of natural resources), Māori will determine the use of supercritical geothermal resources and make influential decisions. The long-term nature of such projects require a multigenerational approach to resource management, which aligns with Māori values and worldview.

It is important to note that Māori appear across the breadth of stakeholders (Table 2) — we didn't make a 'Māori' stakeholder category because we recognize that Māori are key players in every part of the ecosystem. Access to the geothermal resource is determined by the owner of the land above the resources, and most geothermal fields have a commercial arrangement with Māori owned entity in the form of , for example, ownership, fuel supply agreements, royalties and lease agreements.

We wanted to use our research programme to better connect Te Ao Māori ki te ao rangahau (the world of Māori to the world of research), to facilitate more culturally responsive and effective approaches for undertaking geothermal research and resource development. Additionally, we wanted our science team the opportunity to grow their thinking through exposure to a knowledge system different from their own.

3.1. Approach

How do we build relationships and trust? Strong, authentic engagement is key. We don't always get it 'right', but we are here to learn, to ask questions and to be open about how our thinking is evolving.

Relationship Building

Traditional Māori knowledge systems offers another way to see and think about the world. We aim to create a space where the two knowledge systems come together in a shared space – growing both groups. We are guided by a braided river model (Macfarlane *et al*., 2015): where we meet, we connect and build trust, so when we go into places we don't understand, we already have trust and connection. Through targeted projects, partnerships and communication (including a Māori language version of our website), we hope to offer inspiration and encouragement for building relationships and inter-weaving western science and mātauranga Māori (indigenous knowledge). We are engaging early, inclusively and broadly in order to develop meaningful future relationships.

Upskill Scientists

We focus on engaging with Māori to not only provide information and scientific understanding, but equally to grow our science team's thinking. We aren't just seeking a way to better push out our science to Māori so 'they' can understand it better. But rather, how do the scientists look internally to acknowledge and respect a different way of viewing the world. Our team have been learning about the impacts of historical trauma, and learning what it means to represent the Crown (Government) when we engage with Māori. Changing the engagement approach and expectations to acknowledge our colonial history is beneficial for both New Zealanders and international team members.

Shared Language

We translated our website content into Te Reo Māori (the Māori language), but this was not the end of our language journey. We created an opportunity to understand the practice of others through the delivery of Project Waiwhatu (Waiwhatu = fluid from the core/geothermal). We put together a team including scientists, Māori and a Te Reo linguist. Scientists explained technical concepts, relevant to earth sciences and geothermal, and which were then interrogated and interpreted through a Māori lens and context into a shared language, bringing Te Reo (Māori language) and western scientific language into one space.

3.2. Learnings

(i) Don't rush

Relationships and trust take time to build. Genuine consideration of Māori interests is integral to ensuring that research and long-term projects (like supercritical geothermal) are robust and transparent to the Māori community. Early engagement also allows for a greater understanding of one another's expectations, aspirations and priorities, and increases opportunities to co-design processes and systems. Take time to understand, rather than rushing to inform.

(ii) Develop shared understanding

Contemporary science is hard to relate to. Scientists speak a different language and concepts aren't easily aligned to the natural knowledge systems of Mātauranga (knowledge). Similarly, scientists find it hard to understand and relate to Māori concepts and thinking. Also, words driven by English make no sense in Te Reo Māori (Māori language). Instead, words and concepts are often cobbled together with literal translations for parts of words. For example, *ngawha* means *hot spring*, but is commonly used to replace the word *geothermal*. Identifying key scientific terms and phrases in Te Reo, that Māori and scientists are comfortable using, will provide a shared understanding and a pathway to greater engagement.

4. STRATEGIC PARTNERING

Our partnering includes, but goes beyond, science collaboration. We aim to invite interest from a wide range of stakeholders, national and international, including within the geothermal industry, academia, research, regulatory, business, Māori, the finance sector and government entities (Table 2). The long-term horizon means the journey to a supercritical future for Aotearoa New Zealand is bigger, and longer, than a five-year research programme (which was funded from a contestable fund, and its future funding is not guaranteed.)

4.1. Approach

Our aim is to build a strong foundation of informed allies and champions to ensure the supercritical geothermal prospect and momentum continues beyond the five-year research programme.

Ask, don't Assume

We recognise that our stakeholders have many demands on their time and attention. It is also apparent that many individuals do not understand supercritical geothermal, how it works, or why it is an opportunity. To address this knowledge and attention deficit, we started by asking questions and listening to their responses (taking a human centred approach to solving complex challenges). What do they need? What problems do they need solved? What are their priorities? With this information we can prepare information that is relevant and deliver it in a format (e.g. workshop, webinar, report, fact sheets) that is useful.

Collaborate on Mutual-Interest Projects

We are connecting and building/ maintaining partnerships through collaboration on joint projects that benefit the stakeholder and work towards supporting a supercritical future. Examples of this include:

- Stakeholder representation in the development of a supercritical strategy for Aotearoa New Zealand (Climo *et al.*, 2020a, 2020b, 2020c; Carey *et al.*, 2021)
- Working with the New Zealand Geothermal Association to support submissions to government on legislative reform (e.g. NZGA, 2021a; 2021b)
- Technical experts are working in their area of expertise (self-funded) and outside the scope of the funded research programme, for example, in engineering design and financial modelling, because they believe in and support a supercritical future for Aotearoa New Zealand.

Learning from Others

The research builds on a strong foundation of New Zealand capability in geothermal and aligned (e.g. volcanology, social science) research and development. We have aligned our investigations with other national programmes (e.g. Eclipse, 2022; GNS Science, 2022a, 2022b) and are building relationships with international supercritical and deep drilling programmes. International experience, particularly in Iceland, US and Japan, will be drawn on and where possible translated to New Zealand's circumstances. This is for

both science collaboration and also shared learnings about other practicalities, such as financing, regulation and social license. Our international advisory group is key to building these partnerships, assisting us to engage with the international community, and think critically about the work being undertaken and its relevance, application and accessibility.

4.2. Learnings

"Most people overestimate what they can do in one year
and underestimate what they can do in ten years." [Bill Gates]

(i) There is a lot to do

The challenge is to go beyond conventional geothermal systems, and into uncertainty, in order to determine if supercritical geothermal is a viable energy opportunity for Aotearoa New Zealand. There are barriers and opportunities, and we can't do everything at once. In addition to advancing scientific and technical knowledge, on resource delineation, characterisation and sustainability, best practice information is needed for engagement, planning and regulatory frameworks, market and financial analysis, and the handling and use of supercritical fluids. But we do have time, proven capability and growing experience to throw at this challenge.

(ii) Be patience, but persistent

We must remember that we are on a long journey, and that every advancement adds to the collective knowledge, experience and community building. We have to remember that 'The Next Generation' refers to building the next generation of scientists, decision-makers, leaders, research methods and innovative technologies, and that this research programme is just a start.

(iii) Individuals can make a difference

Realising supercritical geothermal for Aotearoa relies on the energy, enthusiasm and expertise of a wide range of people to develop and deliver it. Forming a like-minded team is essential, and inviting others to join and act is needed to deliver across disciplines, sectors and skill sets. Finding and empowering champions in key arenas (e.g. government policy, regulatory processes, well design) helps to grow the team, capacity and networks.

5. AUTHENTIC COMMUNICATION

"When attempting to encourage the adoption of a new technology it is important to take into account the complex nature of human decision making and to recognise it is a social process." (Doody & Becker, 2010).

To have influence over the long term, we ask our stakeholders to give us their trust – a most precious taonga (treasure). This means we must be authentic in our communication - sharing our thoughts and ideas, and being honest about our excitement, lessons learned and uncertainties (Figure 4). Supercritical geothermal has many unknowns, and we don't claim to have all the answers.

To be ready for the future, and ensure ongoing interest, we aim to take our stakeholders with us on a journey of shared knowledge creation. We invite our stakeholders to form their own opinions and to assess short- and long-term opportunities from their viewpoint, and to feed this information back to us to improve our research.

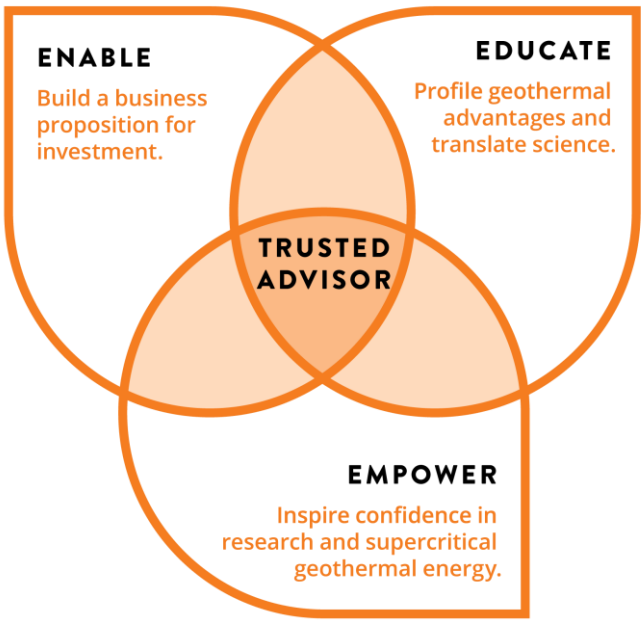

Figure 4: We seek to build trust by enabling, educating and empowering our stakeholders.

5.1. Approach

Our communication goals are:

- Translate and disseminate knowledge learned during the research and associated activities
- Engage with key stakeholder groups to onboard and glean support for the utilisation of supercritical geothermal energy
- Connect groups and individuals that can influence the uptake and investment in supercritical projects
- Promote the research, people and organisations
- Inspire others to join us
- Inform wider Aotearoa New Zealand and the world on the work being undertaken

Our approach from the outset was to be competent, open, honest and consistent, and to share with stakeholders the information they need to make informed decisions. We committed to building a brand that will live beyond the term of the currently funded research. We developed a public, online interface for delivery of information, and to inspire a visitor's curiosity. By curating information, we aim to ensure quality and build more meaningful connections. On our website, in addition to the static content, we committed to publishing a weekly 'updates' post. These range in style and content, covering basic explanations of scientific concepts, sharing research findings, and providing an assortment of information to engage our stakeholders. We share these posts to social media platforms, primarily LinkedIn and Facebook, to gain wider reach.

5.2. Learnings

(i) Science posts get the most interest

Our most widely read and shared articles are those with a focus on the current science and research. This emphasises the importance of undertaking quality science, and the timely dissemination of research results.

(ii) A website alone is not enough

Many research programmes have a website to share research results and publications, but this is only useful as a static communication channel. A website allows one-way push of information to a wide variety of people simultaneously, but it does not target nor personalise. Social media extends the reach of the website content, but rewards regular posting and engagement, which is not often aligned in timing with the academic publishing route. Other communication channels, like webinars, workshops, and face-to-face meetings are also critical for effective engagement.

(iii) Leverage personal networks

We share website content to social media using a research project account (on Facebook and LinkedIn), but it is the sharing of content by team members' personal social media accounts that gets the most reach and interaction. Why? Because human decision making is a social process (Doody & Becker, 2010). Important advisory sources of information include family and friends, and advice from experts and other bodies considered to provide independent and neutral information. When our research content is seen to be endorsed by trusted individuals, the messages have greater impact.

(iv) Culture change is very, very slow – especially in academia

To build a strong stakeholder community, and take them on this long-term journey to supercritical geothermal, we had hoped to share interim results, methodologies, thoughts and ideas as the research progressed. We did not want to compromise reputable work, nor did we expect fast solutions, nor to oversell the results (though this is perversely incentivised in the academic/research sphere because funding is competitive and rewards new, big, important topics; Belluz *et al.*, 2016; Stone, 2021). We had hoped in our stakeholder engagement and communication strategy to find a balance that supported ongoing communication of ideas and the development of research publications.

But we underestimated the massive inertia of the academic system, and the push back that would come from the researchers themselves. Researchers get little recognition for advancing science through informal idea sharing, and their focus (caveat: this is a broad generalisation) is on getting credit for what they ultimately publish. The research culture is used to working away in private and, eventually, producing 'polished' research findings, usually in the form of a journal article—that is often paywalled, and is written for an academic audience, not the layman. Thought processes are hidden, few failures are shared, and in this format and style, the research is rarely placed in a policy-ready context.

We have not achieved our original communication goal of open sharing of science results during the research process. After three years into a five year research programme and delivery of over a hundred blog style posts on our website, only 20% of posts could (very generously) be claimed as direct updates on GNG research activities: field work, analyses, stakeholder consultation or publications. And of these, half the posts were geoscience focussed and the other half centred on either regulatory change or stakeholder engagement. These observations acknowledge the disruption caused by the COVID pandemic (affecting two from three years), particularly to academic conferences. However, we don't have a quick fix for changing culture and institutional/system inertia to support more open communication of research. In mid-2022 the decision was made to change the online communication strategy and resourcing: we no longer provide filler content and will not be consistently blogging nor posting to social media. Rather, content will only be published when there is a research output to share. The outcome of this decision, and its effect on stakeholder engagement, will be shared in future.

(v) Connect with allies

The *Geothermal: The Next Generation* research programme is just a small part of the overall activity that is required to realise a supercritical future for New Zealand. Coordinated activity is required across multiple sectors to unlock the supercritical resource potential, and address technological, engineering, operational, legal, regulatory, economic and other barriers. We are connecting with like-minded allies (e.g. geothermal industry, research, business, Māori, and government) to access their communication channels and improve the reach and targeting of our content.

6. SUMMARY

Stakeholder engagement and communication are key for advancing research uptake and making a change in the world. The *Geothermal: The Next Generation* research programme was an opportunity to try something new in the way we engage, particularly within the scope of a long time horizon to technology implementation, and when technology success is uncertain. The global and national low-carbon energy transition is underway, and supercritical geothermal should be part of Aotearoa New Zealand's future energy portfolio.

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