To
Resource Policy
Ministry of Business, Innovation and Employment
PO Box 1473
Wellington 6140
resourcesfeedback@mbie.govt.nz

From
NZ Maori Council
c/o Donna Hall
Woodward Law

NZ MĀORI COUNCIL SUBMISSION ON 'FROM THE GROUND UP – A DRAFT STRATEGY TO UNLOCK NEW ZEALAND'S GEOTHERMAL POTENTIAL'

Submitter: NZ Maori Council

Contact Person: Donna Hall, Woodward Law

A. Are you happy for MBIE to contact you if we have questions about your submission?
☒ Yes ☐ No

B. Are you making this submission on behalf of a business or organisation?
X Yes ☐ No

New Zealand Māori Council

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NZ Māori Council Submission on 'From the Ground Up – A draft strategy to unlock New Zealand's geothermal potential'

1. The NZ Māori Council supports the From the Ground Up Strategy

The NZ Māori Council supports the aspiration of the New Zealand Government to unlock our geothermal potential through better resource delineation, promotion of innovative technologies and sensible regulatory processes that will facilitate the types of applications profiled in MBIE's draft geothermal strategy.

2. NZ Māori Council Concerns with the Strategy

The Council is concerned, however, that the draft does not address many of the most important matters constraining utilisation of New Zealand's geothermal resource.

By not addressing these issues, we risk not achieving necessary investment in New Zealand's energy security, and opportunities for promoting regional development and betterment of Māori and wider communities.

The Council agrees that New Zealand's geography has given us a unique geothermal advantage' however a lack of resourcing in key areas, e.g., maintaining technical excellence and enhancing system knowledge, is concerning. New Zealand is no longer seen as the global leader in geothermal development.

Although geothermal energy contributes nearly one-fifth of New Zealand's annual electricity generation, is a strong tourism attraction, and geothermal heat and steam are utilised both directly and indirectly in industrial, commercial and residential applications, opportunities have been missed and an appropriate strategy is needed to address identified challenges and attract investment.

The Council supports the vision for New Zealand to enhance its status as a global leader in sustainable geothermal development by pursuing the interconnected strategic outcomes highlighted in the draft strategy, which centre on world- leading geothermal innovation, accelerating energy resilience, and strengthening regional economies and Te Ōhanga Māori – The Māori Economy Report.

However, the Council does have issue with aspects of the proposed five action plan goals, which are of considerable interest to Māori, as tāngata whenua and kaitiaki of our geothermal taonga, landowner and investor, which currently lack detail and require

considered debate to avoid ambiguity and promote viable next-step opportunities and initiatives.

3. MĀORI TREATY CLAIMS TO GEOTHERMAL RESOURCES

To Be Added - Summary of Tribunal hearings and findings to date – Incl. Wai 2358

4. RESPONSE TO SPECIFIC QUESTIONS

A. Are the three strategic outcomes of the strategy suitable, or is there more we need to consider?

The three strategic outcomes are:

i. Extend New Zealand's position as a world -leader in geothermal innovation

ii. Accelerate energy resilience through the development of increased electricity generation and harnessing geothermal heat to support New Zealand's energy transition.

iii. Strengthen regional economies and te Ōhanga Māori by advancing geothermal development in collaboration with tangata whenua, and unlock industrial growth, tourism and trade to support New Zealand's goal of doubling exports.

5. THE NZ MĀORI COUNCIL SUPPORTS THE THREE STRATEGIC OUTCOMES

- The Māori Council **supports the proposed three strategic outcomes** on which the strategy is built but is concerned that the pathways to achieving these outcomes are not adequate.
- Since 1984 **New Zealand has lost its position as a world leader in geothermal expertise**. New Zealand has the capability to rebuild its international leadership but this will require a **partnership between Government, the private sector and Māori enterprises**.
- The countries who are now the world leaders in geothermal, such as Iceland have achieved this because of the support they get from government.
- In Aotearoa where support has been provided to individual Māori through scholarships etc those individuals have been able to **provide the necessary leadership for geothermal development**.
- New Zealand will only be **recognized as a world leader** if it is 'walking the talk' with regard to development of New Zealand's own geothermal resources.

- While the emphasis on electricity generation from geothermal resources is important to assist New Zealand achieve a resilient energy supply, the same degree of **application to non-electricity outcomes needs to be expanded**.
- These non-electricity outcomes, include **direct use of geothermal energy which is often achieved at lower levels of capital investment**. These less capital-intensive opportunities allow many other investors to invest.
- Investment in non-electricity applications generally provide greater regional and te Ohanga Māori [Māori Economy] **benefits including jobs creation** and supporting tourism and industry.
- The dominance of geothermal energy being used to produce electricity has **crowded out potential smaller players and in particular Māori enterprises**.

6. DO THE FIVE OVERARCHING ACTION PLAN GOALS CAPTURE THE AREAS THAT ARE MOST IMPORTANT FOR ACHIEVING THE VISION, STRATEGIC OUTCOMES AND ENERGY GOAL?

(1) THE NZ MĀORI COUNCIL SUPPORTS IMPROVING ACCESS TO GEOTHERMAL DATA AND INSIGHTS

- Good quality geoscience and **engineering data is integral to good decision-making**, and at an early stage can attract investment, advance a resource assessment, **de-risk high-cost drilling**, provide data for preliminary steam field and plant design, or show a geothermal resource is not prospective for power, but may have **attributes suited to (lower temperature) direct use**.
- Geological data related to geothermal exploration and storage is crucial for both resource management and environmental protection. This data, including subsurface information, well logs, and seismic surveys, is used to identify potential reservoirs, monitor drill sites, and ensure safe and efficient operations.
- **Detailed geological data, including core samples and seismic surveys,** helps in **identifying potential geothermal reservoirs and understanding their properties** (e.g., porosity, permeability). Geological data guides the planning and execution of drilling operations, ensuring safe and efficient well placement and trajectory. Monitoring geological data during geothermal field production helps **optimize extraction rates and manage reservoir pressure**.
- Geological data represents a significant investment in exploration and development. Proper storage and management ensure that this data is preserved for future use and analysis. Regulatory consent conditions often require the archiving of geological data for compliance purposes, including environmental regulations and reporting

requirements. Preserved geological data can be used for new exploration projects, reducing the need for costly re-surveys and accelerating the discovery process. Proper storage and management of geological data help mitigate operational and safety risks.

- Data collected by the New Zealand Government from the 1950's provided insight and confidence to progress all geothermal power developments in New Zealand. Many other prospects were explored, and information exists that should benefit prospective developers of those geothermal areas. The **data should be collated and publicly available, as should data collected through past New Zealand funded research** (assuming reasonable opportunity afforded to publish findings in scientific literature), to ensure data is not 'lost' to otherwise inaccessible personal / researcher databases.
- That data may be old does not diminish its value for resource delineation and commercial decisions, assuming raw data is also available for interrogation. Ambiguities / data gaps are generally addressed by a prospective developer via in-house science / engineering capability or by their advisors, with old data integrated with results from newly commissioned surveys.
- The coordinator of the database should be industry-focused, and **arguably independent of those providing advice to identify data gaps**, for fostering competition or "unlocking" commercial opportunities.
- Reference to "real-time" geothermal data reflects information obtained during drilling operations, well testing or plant operation, which is likely to be confidential to the developer / operator. New geoscience survey results will be integrated into updated conceptual and numerical models, and likely proprietary to the developer (and annual reporting / consent condition), with a mechanism for the results from any **NZ Government-funded surveys to also be appropriately added to the database**. The developer may wish to publicize their achievements or results in science / geoengineering publications.
    - The cost of acquiring data is such that only wealthy investors can participate in exploration of geothermal opportunities. **This has resulted in the many Māori entities from not being able to participate in geothermal investments**. If data that is not being used by early explorers, or data that has common value to other entities with an interest in developing a resource over which there are many different parties, this data should be made available to these other parties to use.
    - A publicly available database could be administered via an established Crown Research Institute or, preferably, a geothermal body (**Centre of Excellence?) dedicated to supporting geothermal initiatives in New Zealand**, capability building etc, who is not challenged by commercial objectives. Availability of resource data will be a catalyst for developing geothermal opportunities and relationship building in areas of interest.

- There needs to be clarity regarding roles and responsibilities for data management as currently most data is held confidentially with some resource conditions requiring only specified data provided to the consent authority. This allows data obtained from geothermal exploration to be held privately even when not being used by the original collector of the information. **There should be a legislative requirement that if the information is not used within a specified time period that it can be made open access to other parties**. This would avoid the unnecessary cost of repeat exploration by other potential development parties.
- New Zealand already has regulatory geological data storage provisions for storing oil and gas geological data and limited geothermal data, which is made public after specified time periods if not used by the data collector. Under the Crown Minerals Act 1991 the Oil and gas data storage is managed by NZ Petroleum and Minerals (NZP&M) and involve data submission standards and a national data repository. The exploration permits require the submission of data to NZP&M. **These regulations aim to ensure proper management of geological data, including exploration results, well information, and core samples**. The exploration data, including data acquired from oil and gas exploration, is made publicly available after a specified period (typically five years or at permit expiry).
- GNS Science manages the Geothermal and Groundwater (GGW) database. This database stores data from over 1500 sites across New Zealand, focusing on hydrological, geochemical, geological, and geophysical information related to groundwater and geothermal systems.
- The Māori Council requests that the **strategy should include an action to require geothermal exploration data collected as part of a resource consent**:- Be stored within an independent entity similar as is done with oil and gas data by NZP&M. - Be put into open access if the data has not been used within a specified time period.

(2) New Zealand Māori Council supports - Ensuring regulatory and system settings are fit for purpose

- Existing regulatory frameworks in New Zealand have supported numerous conventional geothermal power ("flash-type" and ORC-binary power, injection) and related initiatives, and numerous novel direct uses (ranging from horticulture, prawn-farming, timber and materials processing, Silicon-Lithium extraction etc). We concur, future applications related to new technologies and uses will likely eventuate, and the **regulatory framework must be adaptable to accommodate new ventures and applications.** Māori as tangata whenua are essential partners and have a key advisory role in the process.

- **Regulatory processes should be streamlined, ambiguities removed, and administrative process improved**, although the fundamental considerations for resource use and mitigation of effects on the environment are as valid now, as in the past.
- That is, for any proposed activity to progress in a **sustainable way, with mitigation of effects on surface manifestations, reservoir / subsurface aquifers, other users and potentially impacted communities in the vicinity of the development** or having a clear and identified interest in the initiative.
- The approach to resource management is broadly similar for a low or high temperature development, either for electricity generation or direct use, **albeit framed by its specific consent conditions** (e.g., for fluid disposal, which might be a particular challenge for any corrosive (acidic?) / very hot / high pressure fluid tapped by a future supercritical initiative, although the nature of such fluids in the New Zealand setting is currently unknown).
- **Identification of 'significant' surface manifestations has received considerable attention from Māori** and regional authorities and typically informs which features might be integrated into regular monitoring, and / or receive attention for protection. It is encouraging recognition of unique value is central to the proposed geothermal strategy.

(3) The New Zealand Māori Council supports - Advancing knowledge and uptake of geothermal technologies

- The MBIE draft strategy makes a brief mention to a "durable talent pipeline" – although it is not a 'regulatory' or 'system setting' issue – it is a stand-alone concern. We concur, that a **well-structured academic programme to grow New Zealand trained geoscience and engineering talent**, integrated with expertise from overseas, provides technical continuity and opportunity to expand insight and capability.
- In the past, the University of Auckland offered a highly regarded post-graduate diploma in geothermal technology, in addition to a range of adhoc MSc and PhD courses, from most of our tertiary institutions. Whilst the UoA geothermal diploma is no longer offered other courses have been initiated – however, a reinvigorated geothermal programme, potentially via a **Geothermal Centre of Excellence affiliated with a degree-awarding tertiary institution (such as UoA), but ideally with a campus in Taupo or Rotorua** (near to the geothermal industry), would be a great boost, and would revive our international profile. Training should also accommodate Māori perspectives, and pathways for Māori youth to learn specialist skills that can be applied to geothermal exploration, drilling, plant operations and field (environmental) management practices.

- Strong international partnerships should be encouraged, as it provides an opportunity to tap learnings overseas, new techniques and tools, and a vehicle to promote New Zealand achievements and innovation. Involvement of New Zealand geothermal specialists in IGA, IRENA, AWPRB, IPGT, as well as engaging with MBIE, MFAT, NZTE could be better supported by the New Zealand Government, as the **benefits for engagement can be expected to exceed the 'cost' of assisting New Zealand involvement**.
- The draft strategy also highlights the value of **collaborative relationships across the sector, government and tāngata whenua** – this might be better achieved via a specific (funded) support role (or "geothermal ambassador") under the umbrella of the NZ Geothermal Association (NZGA).
- There is a perception by some people that New Zealand's uptake of direct and indirect use of geothermal technologies (e.g., for industrial heat, district heating and agricultural applications) lags behind other international leaders. Historically we would concur, but that gap is closing, and changing fast – yes, more could be achieved, and there could be mechanisms to subsidize or support initiatives (via EECA or other agencies?), but there are now numerous applications e.g., Geo40 for Silicon and Lithium extraction, Tenon for processing of timber products that demonstrate industrial scale initiatives, whilst applications for honey processing, flower growing, prawn farming, wood pellet/ kiln drying and bathing (from Northland / Ngawha springs, to Maruia, Hamner and elsewhere in the South Island) demonstrate applications are not restricted to large-scale operations. That said, more could be done to **facilitate space heating initiatives, utilizing near-ground surface heat flow, for schools, hospitals and airports**.
- As a consequence, we concur there is a need to provide targeted education, feasibility assessment and demonstration projects to inform potential builders, planners and builders of the geothermal opportunities – this might be achieved through initiatives supported by the NZGA or a specific theme that could be accommodated via a Geothermal Centre of Excellence. We envisage **Māori would have a key role hosting, sharing insight through teaching and research initiatives, and guiding the establishment, evolution and impact of such an institution.**

(4) The NZ Māori Council supports - Enabling place-based geothermal clusters

- We concur, regional clusters can drive innovation, investment and numerous community benefits. We appreciate the role that the New Zealand Government can play and their commitment to **enable coordination and collaboration between landowners, tangata whenua, local authorities, industry and developers**. In

particular, Government has a key role to guide and facilitate funding, either directly or in a financially- structured package, or via other incentives, that can help de-risk projects through targeted support of exploration surveys, investigative drilling and capability building (training).

- There are **numerous undeveloped geothermal resources and areas of anomalous heat flow** across our country, often co-located with areas suited to forestry, agriculture/horticulture and other farming activities, with good access / points of electrical transmission, and nearby urban areas / infrastructure (such as near Rotorua, Kawerau and Taupo), where large industrial scale applications (e.g. data centers, H2-generation or other industrial applications may be feasible. **Māori as tāngata whenua, landowners and kaitiaki are logical partners and co-developers in such initiatives and can be expected to have key development roles.**

(5) The New Zealand Māori Council supports - Driving science, research and innovation

- We commend the New Zealand Government for its significant commitment to the supercritical geothermal exploration project. We know that supercritical hydrothermal studies have been conducted internationally for more than two decades, but no supercritical plant is yet operating globally. However, its energy potential is huge, and New Zealand has a critical opportunity to claim a leadership role and engage more widely in international initiatives in this important area of investigation. Of course, not only drillhole targeting is at issue, as significant research and investment will be required to address drilling technologies (e.g., bit and casing performance), management of (potentially corrosive) fluids and material sciences, plant design / utilisation and regulatory process (who "owns" a supercritical resource that may extend beneath several administrative jurisdictions, **Māori interests and properties with potentially impacted land-owners.**
- In addition to a theoretical supercritical development, there is a necessity for significant **research and development of applications for low temperature resources that occur across the entire country**, with many having significant development potential (including the Tauranga geothermal system, Hauraki Plains, East Coast, Taranaki and West Coast – these resources also warrant investigation as they have potential, and could provide an important 'first-project' for a funded research initiative through a Geothermal Centre of Excellence.

(6) The Māori Council would like to work with the Government on what actions are included in these focus areas.

DOES THE PROPOSED ACTION PLAN CORRECTLY CAPTURE THE NECESSARY GOVERNMENT INTERVENTIONS AND PRIORITIES?

- The proposed action plan is a good start and does touch (at a high level) on issues that will benefit from targeted investment, incentives and support, but is lacking detail and does not meld industry expertise with Māori needs, or clearly recognise those realistic opportunities that can be expected to have near- term success (such as low temperature, and targeted small-modest scale power initiatives) using proven technologies (many developed in New Zealand), with aspirational themes (such as the supercritical project) that are not expected to realise their potential for many years (not only reflecting targeting and drilling of challenging deep-holes, but material science and fluid management concerns).
- Engineering design issues, gas management, investment in enhance drilling technologies, down-hole sensors by New Zealand engineering experts), enhanced cement and casing designs, scale inhibition geoengineering and enhanced processes for mineral extraction (such as the significant achievements of Geo40 at Ohāki, and on the World stage) are not profiled in the draft, which are not issues restricted to New Zealand, and can be listed amongst numerous challenges for the global geothermal industry, and needing attention.
- The New Zealand Geothermal industry developed a Standard New Zealand Code of Practice for Deep Geothermal Drilling, which has been adopted by numerous operators internationally. The New Zealand Code, prepared by New Zealand experts, focused on wells between 250 m and 3000 m depth with subsurface temperatures up to 350°C, but was published in 2015 and would benefit revision, to integrate recent drilling technology advances, as well as the need to accommodate drilling into challenging geological environments (e.g. 'hotter and deeper' settings, or with difficult fluid management issues), which would be welcomed internationally.
- In the short-term, the Government could prioritise Māori-coordinated regional power developments, such as to the NE of Rotorua, Horohoro-Haparangi-Atiamuri area in Waikato, or West Coast South Island, which have power potential and could be developed with existing technologies (i.e., reliable geoscience, standard drilling techniques and proven / viable plant technologies), but have not received sufficient attention in past Government-funded exploration, or are possible projects at risk of stalling due to a funding shortfall to facilitate investigative drilling (i.e., to de-risk projects / prove resource characteristics to the satisfaction of potential investors keen to engage with resource owners, including Māori), and for low temperature community, light industry and direct use initiatives at Tauranga, Hauraki Plains and elsewhere.

- The draft strategy does not adequately address the need to consider training and a pipeline for technical expertise. The demise of the New Zealand Geothermal Institute at University of Auckland was a great loss, and a previous approach for the New Zealand Government for regional development funding was unsuccessful. Restructuring of relevant CRI's, internally, as well as via the recent amalgamation of institutes, has resulted in a loss of core expertise, with the research community now poorly coordinated, sitting within a number of institutions (each with their own commercial goals) whom are not well placed to achieve the research goals outlined in the draft. New Zealand would benefit from a geoengineering / science / Māori / planning-focussed Geothermal Centre of Excellence that offers coordinated, specialist technical guidance, degree-level training for New Zealand and international students, and a vehicle for collaborative research (covering geoengineering themes previously highlighted) to move the geothermal industry forward, and achieve the energy objectives of the New Zealand Government.
- The strategy is unclear how changes to New Zealand's regulatory framework will be monitored, in light of the proposed RMA amendment, albeit with hope proposed change will facilitate investment and smooth consenting process, whilst maintaining environmental protections. Since 2005, just five countries have realised an increase in geothermal electric power generation capacity above 100 Mwe (USA, Indonesia, Iceland, New Zealand and Kenya). New Zealand should be proud of its achievement - i.e., New Zealand's total geothermal electricity capacity in 2005 was ~600 MW and is now 1281 MWe - all within a rigorous environmental framework, and provides confidence future initiatives in New Zealand will continue to deliver sustainable, appropriately sized power and direct use.

(7) Is the role for the sector clear? How can the wider geothermal sector play a role (e.g. are there specific actions that the sector could own)?

- The Māori Council don't believe that the role for the sector is clear or necessarily co-ordinated. The challenges facing the New Zealand industry and research community are well known, and **significant technology advances have been achieved in the last twenty years**, building on initial experiences and achievements in New Zealand from the 1950's. Innovation is not achieved in a linear fashion, and responds to new challenges, and opportunities (e.g. technology break-throughs).
- Whereas the sector have common concerns and interests, they compete - whether that it for selling electricity to the market, competing for consultancy services and advice, so the **roles and responsibilities of the sector is unclear and does require coordination**.

- An integrated approach by the New Zealand geothermal research community, industry and regulators is required to support data management, with a newly created Geothermal Centre of Excellence the best vehicle to integrate geoscience and engineering data and technical training , and to coordinate industry, service providers, Māori groups and regulators to promote resource assessments, feasibility studies, services (e.g. Chemical analyses via NZES (formerly GNS Science) specialist analytical laboratory, geophysical surveys) drilling and well testing, as well as to coordinate engagement, planning, and engineering design services by specialist companies and agencies for Māori and international investors, if a prospective developer is unsure of best practice / next steps for resource exploration and development. All existing developers, research organisations and service providers have a mutual interest in success of New Zealand geothermal initiatives, regardless or not of direct involvement.

The New Zealand Māori Council does not believe that the strategy and proposed action plan create the right settings to enable tāngata whenua to realise their aspirations for geothermal resources in their rohe?

- The strategy recognises tangata whenua / **Māori have had limited opportunity to access and utilise past resource data, or the financial ability to engage consultants to conduct geoscience** / resource delineation surveys, or fund expensive investigative drilling, planning or feasibility studies. In many cases, Māori aspirations have been thwarted, and opportunities have been lost that would otherwise have provided health and well-being benefits and positive economic / financial impacts, which could in turn have facilitated other regional developments through co-located initiatives.
- As a consequence, the strategy provides the foundation for greater recognition of Māori geothermal research and development interests, and pathway for investment and support, but no detail and little clear direction how improvements will be enacted, who does what, how leadership is coordinated, and timeframes for meaningful / deliverable outputs and achievements. These issues need to be addressed as a matter of urgency.

Are there opportunities for our geothermal sector that we haven't considered?

- **The New Zealand Māori Council considers that there are other opportunities that haven't been considered.**

i. As outlined earlier, there is need to ensure the regulatory process is fit for purpose, with meaningful and effective engagement, contribution / roles and responsibilities for Māori -as tangata whenua an opportunity to engage, support and assist with technical advice offers pathways for down-stream industry to benefit, in addition to the obvious health and well-being of iwi, the environment and for other initiatives. Expertise and knowledge sits with Regional Councils that is not well represented in the Strategy.
ii. Training and education for geothermal technical expertise needs to be better addressed.
iii. System delineation, particularly for low - moderate temperature resource need to be addressed. At the moment there is NO single New Zealand Government agency to conduct this work, as there was in the 1950's with the combined geoscience and engineering experience of DSIR, WORKS and other engineering groups who were dedicated to geothermal development, who were not drawn into other science initiatives at the whim of management.
iv. There are key areas of research that warrant attention, including : gas management, investment in enhance drilling technologies, down-hole sensors by New Zealand engineering experts), enhanced cement and casing designs (especially for any supercritical initiative), scale inhibition geoengineering and enhanced processes for mineral extraction. Now, these activities need to better coordinated, as they address issues of concern to the international community and can impact, and provide commercial opportunities, beyond our shores.
v. An updated Code of Practice for Deep Drilling would have an international impact - particularly if translated for international users.
vi. The roles of NZTE, MFAT and other NZ Government agencies offer an opportunity to engage internationally and have a meaningful influence, and provide a pathway for investment in New Zealand, and commercial opportunities for our experts around the World.

- **Are there challenges for our geothermal sector that we haven't considered?**
  i. In New Zealand, Regional Councils like the Bay of Plenty Regional Council (BOPRC) and the Waikato Regional Council designate geothermal fields based on their characteristics and value, often classifying them into groups or management zones within their regional policy statements or plans. These **designations protect outstanding natural features, significant ecosystems, and cultural values**, ensuring sustainable management through a combination of regional policy, resource consents, monitoring, and public education.

ii. However, the decision making, at least with cultural values, is not widely canvased leading to an almost **arbitrary decision regarding classifications some fields**, at least as far as Iwi are concerned.

iii. Place based geothermal clusters would provide **targeted funding for a durable talent training pipeline, especially regarding matauranga Māori cultural values**. This would support the idea that training should accommodate Māori perspectives.

19/9/25

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From the Ground Up – A draft strategy to unlock New Zealand's geothermal potential

The Submitter

The New Zealand Māori Council (NZMC) represents 16 district councils across the country, many of which are situated in areas that have direct links to geothermal energy. The 1962 Māori Community Development Act governs the NZMC and is the only standing Māori leadership council with direct statutory authority to represent Māori interests.

The NZMC's interest in geothermal energy stems from the fact that many geothermal "hot spots" are owned by Māori; therefore, the Council has an obligation to ensure that Māori voices are heard. The NZMC is mostly concerned with the allocation of resources in the geothermal sector as well as policy development regarding overlapping claims and interests in the geothermal sector.

The NZMC has been involved with geothermal policy since its inception, bringing forward Wai claims 2357 and 2358. Wai 2357, which directly relates to the sale of power companies, which include those that own a geothermal resource and actively generate power with geothermal power. Wai 2358 is an ongoing claim that looks at all freshwater and geothermal interests and helps shape crown policy regarding the rights of Māori to use that resource as well as providing historical context to the use of this taonga.

Introduction

The NZMC supports the aspiration of the New Zealand Government to unlock our geothermal potential through better resource delineation, access to data, promotion of innovative technologies and sensible regulatory processes that will facilitate the types of applications profiled in MBIE's draft geothermal strategy. The Council is concerned, however, that the draft Strategy does not address many of the most important matters constraining utilisation of New Zealand's geothermal resource. It is pleasing that the proposed Strategy acknowledges these issues as set out in the Treaty claim Wai 2358 but these must be addressed before a sensible Strategy can be developed. By not addressing these issues, we risk not achieving necessary investment in New Zealand's energy security, and opportunities for promoting regional development and betterment of Māori and wider communities.

The Council agrees that New Zealand's geographical location has given us a unique geothermal advantage but a lack of resourcing in key areas, e.g., maintaining technical excellence and enhancing system knowledge, is concerning. New Zealand is no longer seen as the global leader in geothermal development. Although geothermal energy contributes to nearly one-fifth of New Zealand's annual electricity generation, is a strong tourism attraction, and geothermal heat and steam are utilised both directly and indirectly in industrial, commercial and residential applications, opportunities have been missed or under-resourced. Therefore, an appropriate Strategy is needed to address identified challenges and attract investment.

The Council supports the vision for New Zealand to enhance its status as a global leader in sustainable geothermal development by pursuing the interconnected strategic outcomes

highlighted in the draft Strategy. These centre on world-leading geothermal innovation, accelerating energy resilience, and strengthening regional economies and te Ōhanga Māori. However, the Council does have issue with aspects of the proposed five action plan goals, which are of considerable interest to Māori, as tāngata whenua and kaitiaki of our geothermal taonga, landowner and investor. These currently lack detail and require considered debate to avoid ambiguity and promote viable next-step opportunities and initiatives.

The Council agrees with the important statement on page 12 that "... much of our current geothermal infrastructure is built on exploration led by the Crown decades ago. Since then, development has been incremental and fragmented." Further, that "Exploration has stagnated since the Crown's initial drilling efforts, with high upfront costs ….and fragmented access to geothermal data." There is a strong nexus between the drop off in infrastructure development and the withdrawal of the Crown from active and coordinated involvement in geothermal exploration. The cost of exploration of geothermal resources is a major barrier to anyone other than well-endowed electricity companies. To have the Crown return to geothermal exploration, particularly for low to moderate-temperature resources which have previously received sparse attention, and remove the barrier to geological data for potential investors would be a major step towards achieving the goal of the Strategy.

While it is acknowledged that there are some government funding mechanisms available these require co-funding and generally require a prior level of knowledge and expertise which is where small potential investors in geothermal opportunities require assistance.

Māori interest in geothermal

There is long-term historical evidence that Māori have a claim over geothermal interests in Aotearoa. Hapu from Te Arawa Lakes tell of Ngātoroirangi, who, in the cold winter, called out to his sisters to help warm himself. His sisters replied by travelling from Hawaiki in the form of fire below the earth. This fire bubbled to the surface, creating geysers and geothermal pools where Ngātoroirangi could warm himself. Thus, the Ngātoroirangi sisters saved their brother's life and created what we now know as the Taupo volcanic zone.

Stories like this demonstrate that Māori have been intrinsically linked to geothermal energy since their first settlement in New Zealand. It has been used for heating, cooking, and healing, and has been integral to the survival of several Hapu.

Now, the interests in geothermal energy are less focused on cooking and healing, but rather on the exploitation of geothermal energy for power generation. As Māori are the Kaitiaki of this taonga, it should be decided by them how the energy is used, ensuring that tikanga is honoured and that there are no long-term environmental impacts from the use of geothermal energy.

Māori Treaty claims to geothermal resources

Currently, the Waitangi Tribunal is in Stage 3 of the Wai 2358 Inquiry, which focuses on Māori rights and interests in geothermal resources, as well as Crown policies and practices in respect of those resources.

The Inquiry is currently in the hearing phase, meaning that no reports have been published detailing the findings; however, there are key issue questions that this stage of the inquiry seeks to answer:

- Issue 1: What Māori rights and interests in geothermal resources are guaranteed and protected by the Treaty of Waitangi?
- Issue 2: Is the current law in respect of geothermal resources consistent with the principles of the Treaty of Waitangi?
- Issue 3(a): If the current law in respect of geothermal resources is not consistent with Treaty principles, what recommendations should be made for the reform of the current law? What other recommendations (if any) should be made?
- Issue 3(b): If the Tribunal finds, in answer to issue 1, that Māori as at 1840 exercised tino rangatiratanga in relation to geothermal resources and in accord with their unique tikanga, what reform is required to the law (if any) to provide for the exercise of that tino rangatiratanga and to recognise their unique tikanga with respect to those resources?

Response to specific questions

1. Are the three strategic outcomes of the strategy suitable, or is there more we need to consider?

i. Extend New Zealand's position as a world -leader in geothermal innovation
ii. Accelerate energy resilience through the development of increased electricity generation and harnessing geothermal heat to support New Zealand's energy transition.
iii. Strengthen regional economies and te Ōhanga Māori by advancing geothermal development in collaboration with tangata whenua, and unlock industrial growth, tourism and trade to support New Zealand's goal of doubling exports.

1.1 The Māori Council supports the proposed three strategic outcomes on which the strategy is built but is concerned that the pathways to achieving these outcomes are poorly defined and not adequate.

1.2 New Zealand has lost its position as a world leader in geothermal expertise. New Zealand has the capability to rebuild its international leadership but will require a partnership between Government and the private sector, particularly to support Māori enterprise. The countries who are most conspicuous as leaders in geothermal innovation, such as Iceland, achieved this status because of support from their government.

1.3 Where support has been provided to individual Māori, through opportunities such as scholarships, those individuals have been able to provide significant leadership for geothermal development by Māori entities. Such personal development schemes should be reinstated.

1.4 New Zealand will only be recognised as a world leader if it is 'walking the talk' with regard to sustainable utilisation of New Zealand's own geothermal resources.

1.5 While the emphasis on electricity generation from geothermal resources is important for New Zealand to achieve a resilient energy supply, consideration of non-electricity investment outcomes need to be targeted and expanded. Direct use of geothermal energy is often achieved at lower levels of capital investment, and these less capital-intensive opportunities allow many other small investors to invest.

1.6 Investment in non-electricity applications generally provide greater regional and te Ōhanga Māori benefits including jobs creation, support for geo-tourism, and co-located industrial applications with economic impact.

1.7 The dominance of geothermal energy being used to produce electricity has crowded out potential smaller players and in particular, Māori enterprises.

2. Do the five overarching action plan goals capture the areas that are most important for achieving the vision, strategic outcomes and energy goal?

2.1 Improving access to geothermal data and insights

2.1.1 Good quality geoscience and engineering data is integral to sound decision making, and at an early stage can attract investment, advance a resource assessment, de-risk high-cost drilling, provide data for preliminary steamfield and plant design, or show a geothermal resource is not prospective for electricity generation but better suited to (lower temperature) direct use.

2.1.2 Geoscience data related to geothermal exploration and reservoir storage is crucial for resource management and environmental protection. The data, including subsurface geological information, well logs, and results of geochemical and geophysical surveys, is used to identify prospective reservoirs and to understand their character (e.g., porosity, permeability). Geological data guides the planning and execution of drilling operations, ensuring safe and efficient well placement and trajectory. Monitoring geological data during geothermal field production helps optimise extraction rates and manage reservoir pressure during subsequent field operation.

2.1.3 Geological data represents a significant investment in exploration and development. Proper data management ensures information is preserved for future analysis and use. Regulatory consent conditions often require archiving geological data for compliance. Preserved data can be used for new exploration projects, reducing the need for costly re-surveys and accelerating the discovery process. Proper management of geoscience and reservoir performance data helps to mitigate operational and commercial risk.

2.1.4 The Council agrees with the proposal of establishing baseline data to “catalyse interest, reduce uncertainty, foster competition, and unlock new development opportunities across New Zealand.”

2.1.5 Data collected by the New Zealand Government during the 1950s provided confidence to progress all geothermal electricity power station developments in New Zealand. Many other prospects were explored, and information exists that should benefit prospective developers of those geothermal areas. The data should be collated and publicly available, as should data collected through past New Zealand government funded research (assuming reasonable opportunity to publish findings in the scientific literature), to ensure data is not ‘lost’ to otherwise inaccessible researcher databases.

2.1.6 That the data may be old does not diminish its value for resource delineation and commercial decisions. Ambiguities / data gaps are generally addressed by a developer via in-house science / engineering analysis or their advisors, with old data integrated with results from newly commissioned surveys. The coordinator of the database should be industry-focused, and independent of those providing advice to identify data gaps, fostering competition or "unlocking" commercial opportunities.

2.1.7 We infer that the reference to "real-time" geothermal data is information obtained during drilling, well testing or plant operation, and likely confidential to the developer / operator. New geoscience survey results will be integrated into updated conceptual and numerical models, and likely proprietary to the developer (or reporting required by consent conditions), with a mechanism for results from any Government-funded surveys to be added to the database. The developer may wish to publicise their achievements or results in science / geoengineering publications.

2.1.8 The cost of acquiring data is commonly such that only wealthy investors can participate in exploration of geothermal prospects. This has greatly inhibited Maori participation in geothermal commercial opportunities. If data previously collected by the New Zealand Government is available or has value to more than one entity with an interest in developing a resource, then the data should be available to all parties.

2.1.9 A publicly accessible database could be administered via an established Crown Research Institute or, preferably, a NZ Geothermal Centre of Excellence dedicated to supporting geothermal initiatives in New Zealand, capability building etc. Availability of resource data will be a catalyst for advancing geothermal opportunities and relationship building in regions with geothermal potential.

2.1.10 There needs to be clarity regarding roles and responsibilities for data management. Presently, most data is confidential, with some resource conditions requiring only specified data provided to a consent authority. This allows data from geothermal exploration to be held privately even when not being used by the original collector of the information. There should be a legislative requirement, if the information is not used within a specified time period, that it can be made open access. This would avoid the unnecessary cost of repeat exploration by other potential development parties.

2.1.11 Earth Science New Zealand (ESNZ) manage the Geothermal and Groundwater (GGW) database, with hydrological and chemical data from more than 1500 sites across New Zealand related to groundwater and geothermal systems. Regional Councils hold groundwater data useful for resource assessment and should be included within the data scheme.

2.1.12 New Zealand has regulatory data storage provisions for oil and gas geological data, which is made public after a specified time if not used by the data collector. Under the Crown Minerals Act 1991, the oil and gas data is managed by NZ Petroleum and Minerals (NZP&M) and there are data submission standards and a national data repository. Exploration permits require the submission of data to NZP&M. The regulations aim to ensure proper management of geological data, including exploration results, well information and core samples, which are made publicly available after a specified period (typically five years or upon permit expiry).

2.1.13 The NZMC requests the Strategy should include an action to require geothermal exploration data collected as part of a resource consent be:

- stored within an independent entity similar as done with oil and gas data by NZP&M; and
- put into open access if the data has not been used within a specified time period.

2.2 Ensuring regulatory and system settings are fit for purpose

2.2.1 Existing regulatory processes in New Zealand have supported conventional geothermal power ("flash-type" and ORC-binary power, injection) and related initiatives, and novel direct uses (ranging from horticulture, prawn-farming, timber processing, Si-Li extraction and space heating). Whereas the existing regulatory system is largely fit for purpose, there are regulatory gaps and processes that make it difficult for small and underfunded entities such as Māori Trusts to develop geothermal opportunities.

2.2.2 The Council agrees "Regulatory settings, designed for conventional geothermal use, have not kept pace with low-temperature applications". In addition, future applications related to new technologies and uses will likely eventuate, and the regulatory framework must be adaptable to accommodate new ventures and applications. Māori as tangata whenua are essential partners and have a key advisory role in the process, but as evidence presented to the Waitangi Tribunal in Claim Wai 2358 has shown, this is not working for the long-term benefit of Māori.

2.2.3 Regulatory processes should be streamlined and ambiguities removed, although the fundamental considerations for resource use and mitigation of effects on the environment are as valid now, as in the past. That is, for any proposed activity to progress in a sustainable way, the resource should be well understood, and a strategy in place for mitigation of effects on surface manifestations, reservoir / subsurface aquifers, other users and potentially impacted communities with an identified interest. The approach to resource management is similar for a low or high temperature development, for electricity generation or direct use, albeit framed by specific consent conditions (e.g. fluid disposal, which might be a particular challenge for corrosive / very hot / high pressure fluid tapped by a future supercritical initiative, (although the nature of such fluids in the New Zealand setting is currently unknown)).

2.2.3. Identification of 'significant' surface manifestations has received considerable attention from Māori and regional authorities and typically informs which features might be integrated into regular monitoring and / or protection. It is encouraging recognition of unique value and is central to the proposed geothermal strategy.

2.2.4 The primary regulatory barrier for Māori relate to the need to clarify the rights to use geothermal fluids within the rights to use water. In Stage 1 of the Tribunal's report on the Wai 2358 claim, the Tribunal determined that Māori have rights in fresh water. It is pleasing to see the proposed Strategy acknowledges the Tribunal's pending report on water rights, but establishing a policy ahead of the receipt of the final Tribunal report may result in a policy which is contrary to the Tribunal's findings.

2.3 Advancing knowledge and uptake of geothermal technologies

2.3.1 The Strategy makes mention in the regulatory settings section to a "durable talent pipeline". This is important but it is not a 'regulatory' or 'system setting' issue – it is a concern driven by the lack of a national policy for advancing geothermal knowledge.

2.3.2 We concur that a well-structured academic programme to grow New Zealand science and engineering talent, integrated with overseas expertise, will provide technical continuity and expand capability. In the past, the University of Auckland offered a highly regarded post-graduate diploma in geothermal technology, complementing ad hoc MSc and PhD courses from other tertiary institutions. The post-graduate diploma is no longer offered, but other courses have been initiated – however, a reinvigorated geothermal programme, potentially via a NZ Geothermal Centre of Excellence affiliated with a degree-awarding tertiary institution, ideally with a campus in Taupo or Rotorua (near to the geothermal industry), would be a great boost and revive our international profile. Training should accommodate Māori perspectives, and pathways for youth to learn skills that can be applied to geothermal exploration, drilling, plant operation, planning and (environmental) management practices.

2.3.3 It is noticeable many of today's Māori leaders benefited from scholarships and other assistance programmes, and future leaders can be expected if support is provided to enhance geothermal knowledge and specialist training. Targeted education has been good for Māori, and New Zealand in general, because it helps to overcome the cost barrier many young people face when starting their career. The proposed Strategy should encourage scholarships, so New Zealand develops a pipeline of knowledgeable geothermal experts, particularly from Māori and financially constrained youth.

2.3.4 It is clear New Zealand's geothermal capability was severely impacted by the Government stepping away from a coordinated programme of geothermal field investigations in the mid 1980's, particularly application of geochemistry, which had helped overcome hurdles arising from the high cost of resource characteristion. The momentum of geothermal innovation and world leading technical capability began to erode once the New Zealand Government stopped funding field investigations.

2.3.5 Strong international partnerships should be encouraged. It provides an opportunity to tap learning and new techniques, and a vehicle to promote New Zealand achievements and expertise. Involvement of New Zealand geothermal specialists in IGA, IRENA, AWPRB, IPGT, as well as engaging with MBIE, MFAT, NZTE could be better supported by the New Zealand Government, as the benefits for engagement can be expected to exceed the cost of assisting New Zealand involvement.

2.3.6 The Strategy highlights the value of collaborative relationships across the sector, government and tāngata whenua. This might be achieved via specifically funded support (c.f., "geothermal ambassador") under the umbrella of the NZ Geothermal Association (NZGA). MFAT has previously successfully funded such an ambassador for international geothermal aid initiatives.

2.3.7 There is a perception that New Zealand's uptake of direct and indirect use of geothermal technologies (e.g., for industrial heat, district heating and agricultural applications) lags international leaders. The gap is closing, but more could be achieved with mechanisms to subsidise initiatives (e.g., via EECA or other agencies). There are many examples, e.g. Geo40 for Si and Li extraction, Tenon's processing of timber products that demonstrate industrial-scale initiative, whilst honey processing, flower growing, prawn farming, kiln drying and bathing (from Ngawha springs in Northland, to Maruia and Hamner in the South Island) demonstrate applications not restricted to large operations. That said, more could be done to facilitate space heating, utilizing near-ground surface heat flow, for schools, hospitals / rest homes and airports etc.

2.3.8 There is a need to provide targeted education, feasibility assessment and demonstration projects to inform potential planners and builders of geothermal opportunities – this might be achieved through initiatives supported by the NZGA or a specific theme that could be accommodated via a NZ Geothermal Centre of Excellence. We envisage Māori would have a key role hosting, sharing insight through teaching / research, and guiding establishment and impact of such an institution.

2.4 Enabling place-based geothermal clusters

2.4.1 We concur that regional clusters can drive innovation, investment and facilitate numerous community benefits. We appreciate the role the New Zealand Government can play and their commitment to enable coordination and collaboration between landowners, tangata whenua, local authorities, industry and developers.

2.4.2 The Government has a key role to guide and facilitate funding, either directly or in a financially-structured package, or via other incentives, that can help de-risk projects through targeted support of exploration surveys, investigative drilling and capability building (training).

2.4.3 There are numerous undeveloped geothermal resources and areas of anomalous heat transfer across New Zealand, often co-located with areas suited to forestry, agriculture/horticulture and other farming activities. In New Zealand, thermal areas typically have good access / points of electrical transmission, and nearby urban areas / infrastructure (such as near Rotorua, Kawerau and Taupo), where large industrial scale applications (e.g. data centers, hydrogen production or other industrial applications) may be feasible.

2.4.4 Māori as tāngata whenua, landowners and kaitiaki are logical partners and co-developers in such initiatives and can be expected to have key development roles.

2.5 Driving science, research and innovation

2.5.1 We commend the New Zealand Government for its significant commitment to the supercritical geothermal exploration project. We know that supercritical hydrothermal studies have been conducted internationally for more than two decades, but no supercritical plant is yet operating globally. However, its energy potential is huge, and New Zealand has a critical opportunity to claim a leadership role and engage more widely in international initiatives in this important area of investigation.

2.5.2 Of course, not only drillhole targeting is an issue, as significant research and investment will be required to address drilling technologies (e.g. bit and casing performance), management of (potentially corrosive) fluids and material sciences, plant design / utilisation and regulatory process (considering who “owns” a supercritical resource that may extend beneath several administrative jurisdictions), Māori interests and properties with potentially impacted land-owners.

2.5.2 In addition to a theoretical supercritical development, there is a necessity for significant research and development of applications for low temperature resources that occur across the entire country, with many having significant development potential (including the Tauranga and Hauraki Plains geothermal system, hot springs on the East Coast and West Coast, and anomalous heat transfer in Taranaki – these resources warrant investigation as they have potential, and could provide an

important first National project for a funded research initiative, through a NZ Geothermal Centre of Excellence.

2.5.3 The NZMC would like to work with the Government on what actions and themes might be investigated in these focus areas, and assessing their commercial viability.

3 Does the proposed action plan correctly capture the necessary government interventions and priorities?

3.1 The proposed action plan is a good start and does touch (at a high level) on issues that will benefit from targeted investment, incentives and support. However, it is lacking detail and does not meld industry expertise with Māori needs or recognise those realistic opportunities that can be expected to have near-term success (such as low temperature, and targeted small-modest scale opportunities) using proven technologies (many developed in New Zealand).

3.2 Targeted, low temperature (enthalpy) initiatives should be considered discretely from more aspirational themes (such as the supercritical project) that are not expected to realise their potential for many years, and only within the capability of a small number of very experienced, very well-funded geothermal developers.

3.3 The aspirational opportunities, such as the proposed supercritical project, will not only require targeted exploration, and drilling of challenging deep-holes, but must consider a spectrum of material science and fluid management concerns. The high temperature - pressure, deep-seated opportunities are still a research focus, and not investment ready. They have many issues to address, such as engineering design, gas management, development of enhanced drilling technologies, permeability management, deep down-hole sensors, enhanced cement and casing design and scale inhibition, involving expertise across the New Zealand geoengineering community.

3.4 Other aspirational opportunities which require research before they are investment ready are enhanced processes for mineral extraction (building on the significant achievements of Geo40 at Ohaaki). Their advancements are not well profiled in the draft but can be listed amongst numerous opportunities where New Zealand expertise is already world leading.

3.5 The New Zealand Geothermal industry developed a Standard New Zealand *Code of Practice for Deep Geothermal Drilling*, which has been adopted by numerous geothermal field operators internationally. The New Zealand Code, prepared by New Zealand experts, focused on wells between 250 m and 3000 m depth with subsurface temperatures up to 350°C, but was published in 2015 and would benefit revision, to integrate recent drilling technology advances, as well as the need to accommodate drilling into challenging geological environments (e.g. 'hotter and deeper' settings, or with difficult fluid management issues). It would be welcomed internationally.

3.6 In the short-term, the Government could prioritise Māori-coordinated regional electricity developments, such as to the North-East of Rotorua, Horohoro-Haparangi-Atiamuri in Waikato, or West Coast South Island, which have electricity generation potential and could be developed with existing technologies (i.e., reliable geoscience, standard drilling techniques and proven / viable plant technologies). These opportunities, however, have not received sufficient attention in past Government-

funded exploration, or are projects at risk of stalling due to a funding shortfall to facilitate investigative drilling (i.e., to de-risk projects / prove resource characteristics to the satisfaction of potential investors keen to engage with Maori), and for low temperature direct use initiatives at Tauranga, Hauraki Plains and elsewhere.

3.7 Establishing geothermal development zones in areas where there is geothermal investment potential but currently limited investigations, such as Hauraki, would join the synergies of heat users and heat providers, so economies of scale are achieved. Currently, individual potential investors (e.g., a food processor), are faced with very large exploration costs whereas if they were part of a cluster of energy users then the cost of resource exploration can be shared. This would reduce the current barrier to food processors decarbonising and use geothermal energy rather than fossil fuels.

3.8 Geothermal development zones could be established within wider energy initiatives, where resource consenting is simplified and encouraging of economic development. These zones could include geothermal, solar and bioenergy, so that there is a synergy of renewable energy technology within a cluster of energy users. Such energy zones can provide for Māori entities to participate in renewable energy investments without them having to do the heavy lifting alone. Examples where Māori are partnering with energy companies and energy users, such as at Mōkai, are a good example of how an energy zone concept can be achieved.

3.9 The draft Strategy does not adequately address the need to reevaluate training needs and a pipeline for technical expertise. The demise of the New Zealand Geothermal Institute at The University of Auckland (although numerical modelling capability is retained) was a great loss. Restructuring and recent amalgamation of CRIs has resulted in a loss of core geothermal expertise, and specialists who are poorly coordinated and not well placed to achieve the research goals outlined in the Strategy.

3.10 New Zealand would benefit from a geoengineering / science / Māori / policy-driven NZ Geothermal Centre of Excellence that offers coordinated, specialist technical guidance, degree-level training (for New Zealand and international students), and a vehicle for collaborative research to move the geothermal industry forward and achieve the objectives in the Strategy. An approach to the New Zealand Government for regional development funding for a Geothermal CoE was unsuccessful and should be revisited.

3.11 The Strategy is unclear as to how changes to New Zealand's regulatory framework will be monitored, in light of the proposed RMA amendment, albeit with hope proposed change will facilitate investment and a smooth consenting process, whilst maintaining environmental protections. Since 2005, just five countries have realised an increase in geothermal electric power generation capacity above 100 MWe (USA, Indonesia, Iceland, New Zealand and Kenya). New Zealand should be proud of its achievement - i.e., New Zealand's total geothermal electricity capacity in 2005 was ~600 MW and is now 1281 MWe - all within a rigorous environmental framework and provides confidence future initiatives in New Zealand will continue to deliver sustainable, appropriately sized electricity supply and direct use.

4 Is the role for the sector clear? How can the wider geothermal sector play a role (e.g. are there specific actions that the sector could own)?

4.1 The challenges facing the New Zealand industry and research community are well known. Significant technology advances have been achieved in the last twenty years,

building on the achievements in New Zealand from the 1950s. However, looking ahead, the role of different parties within the sector to expand on past successes and deliver on the next chapter in the New Zealand Geothermal Story are unclear.

4.2 Innovation is not achieved in a linear fashion. It responds to new challenges, and opportunities (e.g. technology breakthroughs). Whereas the sector has common concerns and interests, we recognise there is also competition - whether that is selling electricity to the market, or competing for consultancy services, so the roles and responsibilities of the sector regarding the geothermal Strategy and its objectives will require clarification and coordination, to achieve desired success.

4.3 An integrated approach by New Zealand geothermal researchers, industry and regulators are required. A new NZ Geothermal Centre of Excellence is arguably the best vehicle to integrate geoscience and engineering expertise, data storage and sharing, and technical training, and to meld industry / services with interests of Māori and concerns of regulators.

4.4 In light of the Strategy objectives, work undertaken by a NZ Geothermal Centre of Excellence might include resource assessment and feasibility studies, technical training and services (c.f., chemical studies via NZES specialist analytical / experimental hydrothermal chemical laboratory, or geophysical surveys), coordination of exploration drilling, well testing and engineering design, as well as planning, policy advice and facilitation for international investors (or prospective field operators unsure of best practice / next steps for resource exploration and development).

4.5 All existing developers, landowners, iwi, research organisations and service providers have an interest in the success of New Zealand geothermal initiatives.

5 Does the strategy and proposed action plan create the right settings to enable tāngata whenua to realise their aspirations for geothermal resources in their rohe?

5.1 The Strategy recognises tangata whenua / Māori have had limited opportunity to access and utilise past resource data, or the financial ability to engage consultants to conduct geoscience / resource delineation surveys, or fund expensive investigative drilling, planning or feasibility studies. In many cases, Māori aspirations have been thwarted, and opportunities have been lost that would otherwise have provided health and well-being benefits and positive economic / financial impacts, which could in turn have facilitated other regional developments through co-located initiatives.

5.2 The Strategy provides the foundation for greater recognition of Māori geothermal research and development interests, and pathway for investment and support, but provides no detail and little clear direction how improvements will be enacted, who does what, how leadership is coordinated, and timeframes for meaningful / deliverable outputs and achievements. These issues need to be addressed as a matter of urgency.

5.3 The NZMC agrees with the proposed Action Plan and, as a representative of Māori as a Treaty partner, should be included within the proposed Sector Strategy Implementation Group.

6 Are there opportunities for our geothermal sector that we haven't considered?

6.1 Yes. As outlined, there is a need to ensure the regulatory process is fit for purpose, with meaningful and effective engagement, roles and responsibilities for Māori as tangata whenua. Technical advice offers a pathway for downstream industry to benefit, in addition to the obvious health and well-being of iwi and the environment. Expertise, especially regulatory insight and environmental knowledge sits with Regional Councils that are not well represented in the Strategy. A pipeline for specialist training and education to enhance technical expertise and capability in New Zealand, especially for Māori, needs to be better addressed.

6.2 System delineation, particularly for low - moderate temperature resource need to be addressed. Currently, there is no single New Zealand Government agency who can conduct this work, as there was in the 1950s. During the 1950s, there was the combined geoscience and engineering experience of DSIR, WORKS and other engineering groups who were dedicated to geothermal development, who were not drawn into other science initiatives.

6.3 There are key areas of research that warrant attention, including: gas management, investment in enhance drilling technologies, down-hole sensors by New Zealand engineering experts), enhanced cement and casing designs (especially for any supercritical initiative), scale inhibition geoengineering and enhanced processes for mineral extraction. These activities need to better coordinated, as they address issues of concern to the international community, and can impact and provide commercial and technical-learning opportunities, beyond our shores.

6.4 An updated Code of Practice for Deep Drilling would have an international impact - particularly if translated for international users.

6.5 The roles of NZTE, MFAT and other NZ Government agencies offer an opportunity to engage internationally and have a meaningful influence, and provide a pathway for investment in New Zealand, and opportunities for Māori, our experts and industry.

6.6 The significant barriers which have been provided as evidence to the Wai 2538 must be considered when developing this strategy. In particular, the lack clarity on the rights of landowners, Māori and the conflicts between competing rights must be considered. Developers of geothermal projects need clarity on who has what rights. Without that, clarity developments are unnecessarily unable to proceed.

7 Are there challenges for our geothermal sector that we haven't considered?

7.1 The proposed strategy does not address the principal regulatory barriers to geothermal development. The Strategy acknowledges the Treaty claim Wai 2358 but until this claim is resolved to the mutual satisfaction of The Crown and the Māori claimants, the Strategy is a nullity.

7.2 As evidence to the Waitangi Tribunal has shown, lack of clarity over the rights for Māori to access and use the geothermal resource is a major barrier to geothermal development by any interested party. Potential developers will not proceed with a potential geothermal development if there is uncertainty over Māori rights.

7.3 The proposed Strategy does not include for Māori customary uses of New Zealand's geothermal resource. The Strategy does not address concerns that the NZ Māori Council has over the lack of involvement of Māori as a Treaty partner in the

management of geothermal resources. The first in approach to water allocation does not acknowledge prior customary uses of geothermal waters.

7.4 The lack of clarity of the rights of landowners, other than for land access, is a barrier. A lot of land overlying geothermal fields are owned by multiple landowners. It is unclear as to the rights of these landowners with regard to the use of the geothermal resource under their respective land holdings.

8 Are there any other things that the strategy should include or exclude?

8.1 The Draft Action Plan highlights activities in Horizon 1 / 2025-26 already underway (e.g. promotion of geoheat information and use) but are only vaguely framed here with recommendations to "consider" and "explore". Māori, the geothermal industry generally, and public need to see unambiguous timelines and expected deliverables.

8.2 The Draft Strategy did not receive wide consultation. There is concern the "sector strategy implementation group", or 'commissioned' to report on data gaps, planning environmental legislation, or 'options' for a Geothermal Centre of Excellence, should reflect a spectrum of industry, regulator and community (including Māori) interests – with a team leadership committed to addressing long-term geothermal priorities.

8.3 Greater community engagement and increased awareness will promote uptake and utilisation. Past (commissioned) surveys have indicated good knowledge in some (geographic) regions, but the public remain poorly informed concerning geothermal matters, and practical applications could be better and more widely communicated.

8.4 The undertaking of a "drilling programme for supercritical geothermal" is not well communicated and is optimistic. Deep drilling is not a particularly challenging, presuming a well site has been identified (building on NZ Government funded research, initiatives and debate in New Zealand over the last 15-20 years), but the technologies to "support an install (a) supercritical power station" cannot wait until Horizon 3.

8.5 Horizon 2 proposes 'investigation' of a mechanism for ongoing provision of geothermal data to a central repository" in 2027-28 – this should be enacted now. There is little reason for not making previously acquired resource information, and NZ Government-funded research data, available as soon as practical. An obvious vehicle for data collation and availability is establishment (not just 'explore options) of an independent, accredited NZ Geothermal Centre of Excellence.

8.6 A task force (with members seconded from the NZ geothermal industry, regional experts and community/Māori interests, supported by technical specialists, educators etc) should be established as soon as practical (not deferred to 2027-28) to address the opportunities and incentives to establish regional / renewable energy clusters.

8.7 The suggestion for a "role of policy direction" for managing geothermal resources is ambiguous. There are regulatory, environmental and related issues that are of concern and are arguably best addressed by independent regulatory bodies, and the developer is accountable for sustainable resource utilisation, field management and operational decisions, so the "policy role" expressed in the Strategy (apart from for promotion, facilitation of financial incentives) is unclear. The Strategy does not address concerns that the NZMC has over the lack of involvement of Māori as a Treaty partner in the management of geothermal resources.

8.8 In Horizon 3, it is unclear what is intended by a transition of "government users to geothermal technologies" – namely, whom this may be, their activities and needs.

8.9 Funding mechanisms to facilitate geothermal initiatives (exploration) that will benefit Māori, regional economies, down-stream-users and National interest are a priority. A Crown-funded programme in support of exploration DRILLING is needed. New Zealand agencies can provide specialist services, but there is currently no Government agency equipped to provide the full spectrum of exploration and development services, but there are competent industry consultants who can be engaged, if the aspirant (e.g. a Māori Trust, investor etc) has access to funding.

9 To help us continue to develop a geothermal strategy for New Zealand, we would appreciate any additional suggestions or comments you may have.

The strategy should take note of the success of the Iceland geothermal development as set out in the report by the New Zealand Ministry of Foreign Affairs and Trade. https://www.mfat.govt.nz/assets/Trade-General/Trade-Market-reports/Iceland-green-transition-renewable-energy-September-2024.pdf

To
Resource Policy
Ministry of Business, Innovation and Employment
PO Box 1473
Wellington 6140
resourcesfeedback@mbie.govt.nz

From
NZ Maori Council
c/o Donna Hall
Woodward Law

NZ Māori Council Economic Submission on Draft Geothermal Strategy

Submitter: NZ Māori Council

Contact Person: Donna Hall, Woodward Law

A. Are you happy for MBIE to contact you if we have questions about your submission?
☒ Yes ☐ No

B. Are you making this submission on behalf of a business or organisation?
X Yes ☐ No

New Zealand Māori Council

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Economic Implications of “From the Ground Up”

On behalf of the New Zealand Māori Council

Eaqub & Eaqub Submission to MBIE

Shamubeel Eaqub, Rosie Collins and Nihal Sohanpal

12 September 2025

Background

1.1 This submission was prepared by Shamubeel Eaqub, Rosie Collins and Nihal Sohanpal on behalf of the New Zealand Māori Council, in response to the government’s recent *From the Ground Up* strategy.

1.2 This submission complements the New Zealand Māori Council’s ongoing engagement with the government’s recent geothermal strategy.

1.3 Our views are informed by experience in economic and energy policy. We respond primarily to Question 3 in the draft strategy regarding the government’s proposed interventions and priorities, which we see as directly linked to Question 5, the policy settings necessary for tāngata whenua to realise their geothermal aspirations.

1.4 This strategy is a welcome step toward unlocking more geothermal potential. However, its thinking on early-stage risk-sharing mechanisms, widely used in other geothermal regions, is critically underdeveloped.

1.5 A key challenge for geothermal developers is "resource risk," the uncertainty about what lies beneath the surface. Although New Zealand has strong geothermal science, high risks of dry holes and subsurface uncertainty still hold back new geothermal development.

1.6 We believe the strategy has four key gaps:

- It underestimates the current level of exploration risk and the capital challenges faced.
- Fails to incorporate international best practices such as risk pooling and collective mechanisms that unlock geothermal development. This would be particularly valuable for opportunities on Māori land, which face additional barriers to capital.
- Is overly focused on a single technology (super-critical) rather than enabling a broader portfolio of geothermal resources and technologies.
- Does not appropriately recognise that a significant share of geothermal resources lie on Māori land, which requires additional considerations associated with communally held land. By extension, unlocking Māori geothermal potential has the highest likelihood of unlocking New Zealand’s geothermal potential.

Clarifying the opportunity

1.7 New Zealand has abundant geothermal resources, but exploration (especially at supercritical depths) remains limited. Research indicates that each well can cost between NZ$10–15 million and carries a high risk of failure (MBIE, 2025; Castalia, 2023). The funding and financing systems needed to support this level of risk are not yet in place, and supercritical technology remains unproven at scale globally.

1.8 The draft strategy allocates $60 million from the Regional Infrastructure Fund for supercritical geothermal exploration. This funding is currently earmarked for three exploratory deep wells in the Taupō Volcanic Zone.

1.9 While this targeted drilling approach focuses resources on a small number of high-risk wells, international experience shows that better outcomes can be achieved by using public funding to de-risk a broader set of projects. That is, use public money as an enabler, rather than as a direct funder, multiplying its effect.

1.10 For example, France’s geothermal guarantee funds in the 1980s successfully used public money to crowd in private capital (that is, the public money unlocked private investment by acting as a pooling or insurance mechanism). For every €1 spent on exploration risk coverage, up to €42 of geothermal drilling activity was guaranteed, demonstrating the power of well-structured risk mitigation to unlock private investment at scale.

1.11 Notably, the French programme focused on conventional geothermal depths (adding 500 MW of thermal energy in a short period), showing that effective innovation/industrial policy does not depend on speculative technologies.

1.12 A broader, more inclusive exploration approach could be especially valuable in the New Zealand context. Applying a conservative version of this approach in New Zealand (e.g., assuming a $1 to $20 ratio) could de-risk up to $1.2 billion worth of geothermal exploration across multiple regions and developers at various depths, thereby expanding the pipeline beyond a few wells.

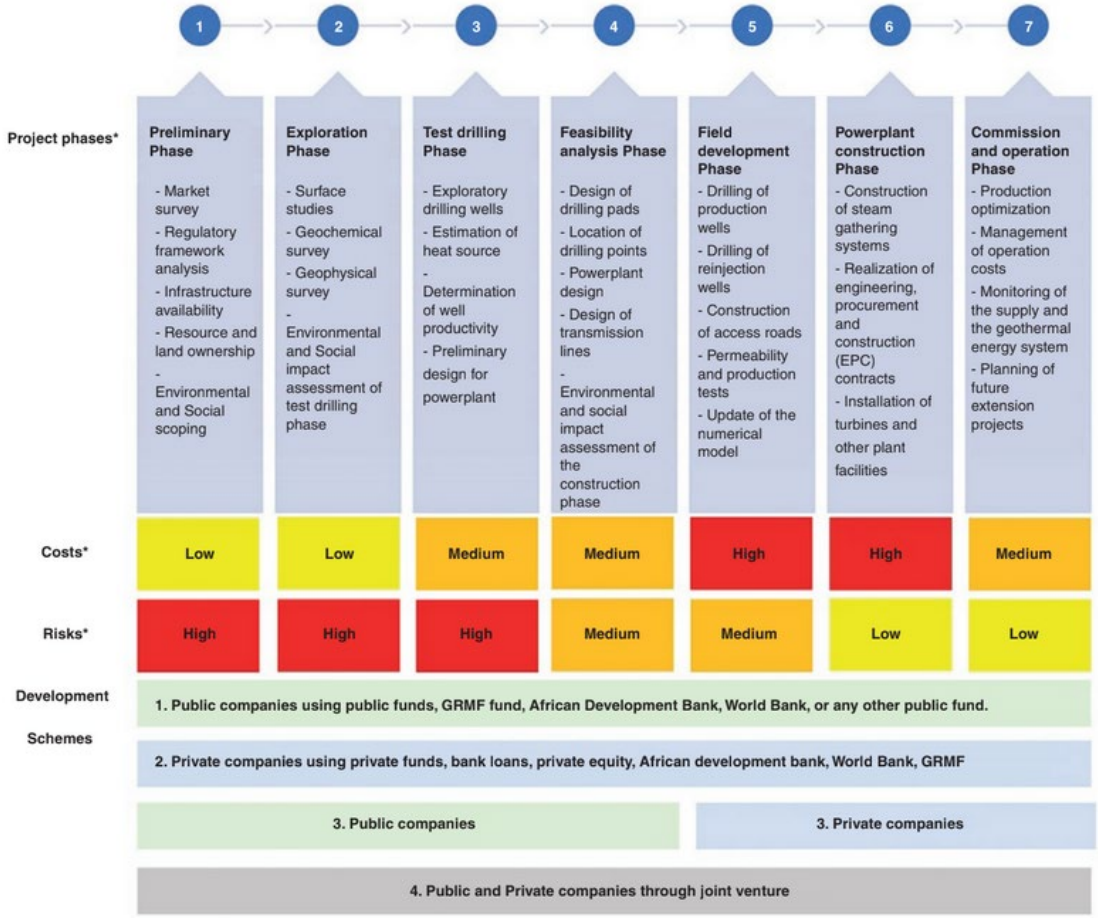
1.13 A risk-sharing mechanism of this nature would critically enable broader participation, particularly from Māori developers who are currently constrained by limited access to affordable capital (direct relevance to Question 5).

Geothermal risk profile across development stages

1.14 Figure 1 (from Abdi et al. 2024) neatly illustrates the geothermal development maturity timeline, highlighting that the greatest uncertainty and risk occur during early exploration stages, although it is not the most expensive.

1.15 Although the current strategy recognises geothermal opportunities, it does not sufficiently address the key barriers, the heterogenous nature of risk across the development cycle, and how to mitigate those. Access to capital is limited in the preliminary phase internationally, indicating a market failure, that government is uniquely positioned to unlock.

Figure 1: Geothermal development pipeline is a complex risk and cost matrix



Source: Abdi et al., 2024.

1.16 Notably, a significant share of New Zealand’s geothermal potential sits on Māori land. This adds two additional issues relating to communally held land, and difficulty accessing capital because of this and because of wider issues of capital access (RBNZ, 2025).

1.17 A key barrier to realising this opportunity is the ability to bear early-stage exploration risk, even though costs at this stage are relatively low. Examples

such as the Nga Awa Purua Power Station demonstrate how geothermal potential can be successfully developed when this risk is addressed. That is, once preliminary exploration risk is addressed, there are established and proven mechanisms to unlock that potential. Public support is not necessarily required in these phases.

1.18 Government drilling in the 1950s de-risked the Rotokawa geothermal field, enabling commercial development. The Tauhara North No. 2 Trust, as landowner, contributed land access and Resource Consent support, while Mercury NZ Ltd (formerly Mighty River Power) provided capital and technical expertise. Mercury held majority ownership at the outset, allowing the project to proceed without requiring the Trust to contribute upfront equity.

1.19 The Trust played a key role in the consenting process and community engagement, securing neighbour support and helping reduce consent processing time to under seven months, compared to the typical 12 to 24 months.

1.20 To obtain a 25 percent equity stake, the Trust borrowed $100 million, secured against future royalty income and its joint venture interest. It increased its stake to 35 percent in 2012 and now earns approximately $20 million in gross revenue each year.

1.21 This partnership model balanced risk, aligned interests, and gained strong community backing, with 95 percent of Trust shareholders supporting the project.

1.22 The New Zealand Māori Council has raised concerns that the current geothermal strategy fails to address early-stage exploration risk. **This is a well-evidenced market failure with tested solutions applied successfully over several decades in other jurisdictions.** The strategy should recommend interventions to unlock geothermal potential by focusing on the market failures only government can address.

1.23 Without government support to de-risk resources, the opportunity on Māori land will stay out of reach. The Nga Awa Purua example shows that Māori landowners are ready to invest, but not while early-stage risk is left unaddressed. **Rather than investing in isolated wells, the government should use its position to collectivise early-stage exploration risk and enable broader Māori participation in geothermal development.** This can take the form of insurance, or underwriting. The effect sought is pooling of risk, so that more drilling takes place, increasing the likelihood of success and associated payoffs.

Interventions abroad

1.24 Several countries have implemented risk mitigation schemes to address the uncertainties inherent in preliminary geothermal exploration. Typically, these schemes provide *insurance* (using various different mechanisms, the key outcome sought is the pooling of risk to pursue a larger portfolio of drilling) against underperformance due to geological risk, often covering the gap between expected and actual geothermal output after drilling. Some focus specifically on deep wells.

1.25 In 2020, the EU’s GEORISK project reviewed 21 such schemes worldwide, categorising them by success levels. Long-standing European programmes, including France’s SAF Environnement, the Swiss 1987 scheme, the Netherlands, and Germany’s national scheme, have proven highly successful (Boissavy, 2020). They attracted private developers, supported project development, and enabled the commissioning of multiple geothermal plants.

1.26 For instance, the Netherlands spurred private investment by introducing a national exploratory investment risk mitigation scheme, expanding geothermal heat production from zero to nearly 2,400 TJ between 2007 and 2015. Although smaller in scale than New Zealand’s geothermal sector, it shows that targeted public intervention can feasibly unlock early-stage projects in a relatively short period.

1.27 In contrast, France’s geothermal guarantee funds from the 1980s supported larger-scale district heating developments, demonstrating a more scalable model of public risk sharing that attracted significant private investment and expanded geothermal capacity substantially.

1.28 France’s geothermal sector grew rapidly in the late 1970s and 1980s, spurred by the energy crises and demand for secure local heating. The Greater Paris region tapped low-temperature aquifers roughly 2,000 metres underground. The French government enabled this by introducing strong public policies including legal reforms, public investment, and dedicated geological risk guarantees.

1.29 Two funds were created: a Short-Term Guarantee Fund (1982) to insure drilling risk and a Long-Term Fund (1981) for operational risks over project lifetimes. These measures de-risked investments and accelerated deployment. Between 1981 and 1986, France developed one of the world’s most successful low-temperature geothermal heating networks. Over two-thirds of those systems remain operational, supplying more than 500 MW of heating capacity.

1.30 **The return to the public was substantial: the Short-Term Fund facilitated private geothermal investments estimated at €42 for every €1 of public**

guarantee, while the Long-Term Fund generated returns of around €33 per euro of public investment (Boissavy, 2020).

1.31 These examples offer valuable lessons for New Zealand. By contrast, newer or less effective schemes such as the Geothermal Risk Mitigation Facility (GRMF) and Geothermal Development Fund have faced challenges including high premiums, inadequate risk coverage, underutilisation, and project delays, with many supported projects still not connected to the grid.

1.32 Critically, the EU’s GEORISK review found that covering at least 60% of drilling costs is essential to attract developers but suggested that this should be seen as a strict minimum, suggesting 90% coverage is optimal (Boissavy, 2020). This suggests the current $60m of funding needs to be designed creatively to mimic these benefits.

Policy frameworks for geothermal development

1.33 Innovation policy for sustainability transitions can be evaluated by their consistency, coherence, credibility, and comprehensiveness as a mix (Rogge & Reichardt, 2016). These qualities help, when pursued over a long time, help to overcome infrastructure lock-in and path dependency (Helmrich, 2023):

- **Consistency:** Alignment of policy elements to achieve goals without contradictions, allowing ongoing coordination and adaptability.
- **Coherence:** Systematic and synergistic operation of policies and implementation, supported by structures like strategic planning.
- **Credibility:** The reliability of the policy mix, including strong funding and financing commitments.
- **Comprehensiveness:** The thoroughness of the policy mix, covering all necessary elements based on broad, informed decision-making.

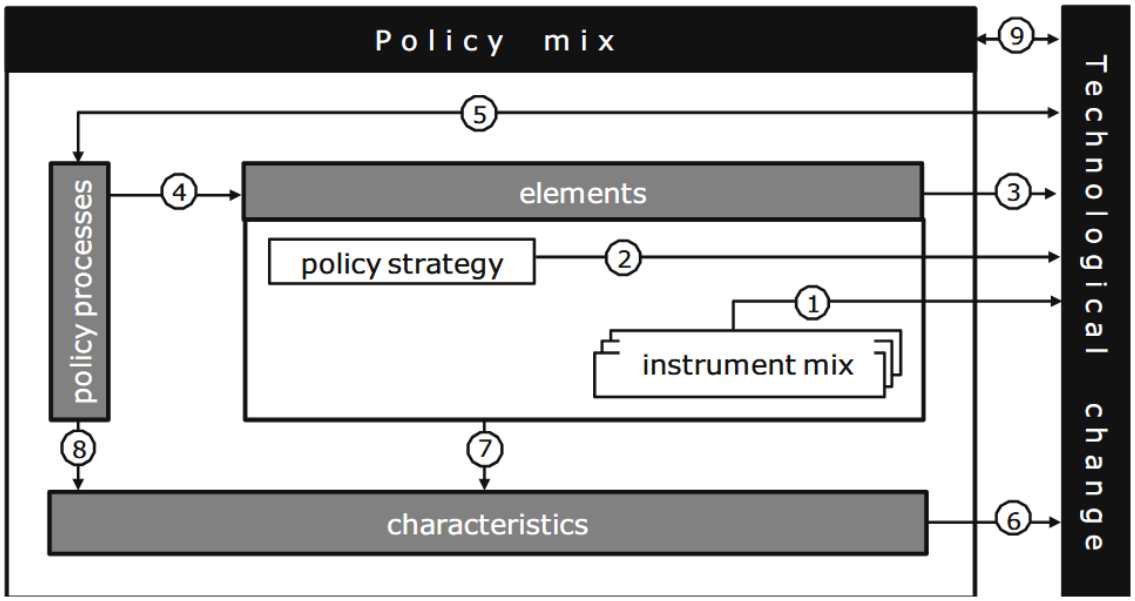


Fig. 3. Framework for analyzing the link between the policy mix and technological change.

Source: Rogge & Reichart, 2016.

1.34 To improve credibility and comprehensiveness, **the government should address gaps in early-stage risk mitigation with clear and consistent policies**. **Ensuring consistency will necessitate a technology neutral approach that avoids an exclusive focus on supercritical geothermal** so that established lower-temperature resources which are proven and more cost effective can also contribute significantly to the energy mix. This portfolio approach will derisk super-critical exploration.

1.35 These are low-hanging fruit. For Māori, this approach would support a broader range of geothermal developments and enable greater participation from Māori landowners who experience greater difficulties in accessing capital. Encouraging diversity in the policy mix spreads risk and fosters a more inclusive and resilient geothermal sector. However, this does not preclude providing enhanced coverage for supercritical drilling where appropriate, as is common abroad.

1.36 As noted in the Nga Awa Purua case study above, later-stage geothermal projects are generally bankable once resource risk is resolved, with commercial capital becoming readily available.

Conclusion

1.37 Early-stage resource risk is a well-established market failure in geothermal development internationally. Proven mechanisms such as exploration risk insurance and risk pooling are widely used overseas but are currently absent from the draft strategy.

1.38 Without such mechanisms, early-stage geothermal investment in Aotearoa New Zealand is likely to remain constrained, with particularly significant impacts for Māori landowners. Aggregating exploration risks prior to drilling in some capacity is essential to unlock access to conventional financing.

1.39 Geothermal projects offer a rare and important alignment of economic, social, and environmental benefits for Māori and should remain a government priority. Future drafts of the strategy should explicitly acknowledge early-stage exploration risks and incorporate targeted risk-pooling mechanisms to support innovation and accelerate geothermal development. To ensure consistency and fairness across technologies, these tools should be technology neutral.

1.40 International experience demonstrates that such approaches are both feasible and effective in unlocking geothermal resources and encouraging broader participation.

References

Abdi, A. M., Murayama, T., Nishikizawa, S., & Suwanteep, K. (2024). *Social acceptance and associated risks of geothermal energy development in East Africa: Perspectives from geothermal energy developers*. *Clean Energy*, *8*(5), 20–33. https://doi.org/10.1093/ce/zkae051

Boissavy, C. (2020). *Report reviewing existing insurance schemes for geothermal risk mitigation* (Deliverable D3.1). GEORISK Project. Retrieved from https://www.georisk-project.eu/wp-content/uploads/2020/02/D3.1_Report-reviewing-geothermal-risk-mitigation-schemes-v2.pdf

Castalia Ltd. (2023). *Supercritical geothermal in NZ: Economic opportunity in renewable electricity generation and for off-grid energy* [Report]. *Geothermal: The Next Generation* Programme. Retrieved from Geothermal: The Next Generation website.

Department of Finance, Canada (2024). *Canada Indigenous Loan Guarantee Corporation*. [online] Canada.ca. Available at: https://www.canada.ca/en/department-finance/news/2024/12/canada-indigenous-loan-guarantee-corporation.html.

Mizuno, E. (2013) *Geothermal Power Development in New Zealand – Lessons for Japan*. Japan Renewable Energy Foundation. Available at: https://www.renewable-ei.org/en/images/pdf/20130220/20120912_lessonfromNewZealand.pdf (Accessed: 4 September 2025).

Fisherriver (2020). *Fisher River Cree Nation unveils Manitoba’s biggest solar farm, a source of Bullfrog Power’s green energy*. [online] Fisher River Cree Nation. Available at: https://fisherriver.ca/2020/08/fisher-river-cree-nation-unveils-manitobas-biggest-solar-farm-a-source-of-bullfrog-powers-green-energy/.

Helmrich, A., Chester, M., Miller, T. R., & Allenby, B. (2023). *Lock-in: Origination and significance within infrastructure systems* (*Environmental Research: Infrastructure and Sustainability*, 3(3), Article 032001). https://doi.org/10.1088/2634-4505/acf7e6

Krupa, J., Busch, F., Gladwin, D., & Ellis, N. (2025). *Financing clean technologies within Canada’s Indigenous communities: Perspectives on sustainable energy transition from practitioners and academics*. Energy, 322, 134930. https://doi.org/10.1016/j.energy.2025.134930

Ministry of Business, Innovation and Employment. (2025, July 30). *From the Ground Up – A draft strategy to unlock New Zealand’s geothermal potential*. New Zealand Government.

Rogge, K. S., & Reichardt, K. (2016). *Policy mixes for sustainability transitions: An extended concept and framework for analysis*. *Research Policy*, *45*(8), 1620–1635. https://doi.org/10.1016/j.respol.2016.04.004

Reserve Bank of New Zealand. (2025, 26 June). *Māori access to capital (MA2K) snapshot*. https://www.rbnz.govt.nz/hub/publications/maori-access-to-capital/maori-access-to-capital-snapshotWiser, R. H., & Pickle, S. J. (1997). *Financing investments in renewable energy: The role of policy design and restructuring* (Report No. LBNL-39826). Environmental Energy Technologies Division, Ernest Orlando Lawrence Berkeley National Laboratory. https://doi.org/10.2172/459384

Yantha, L. (2022). *Financing infrastructure is not a one-time grant* (Nation Rebuilding Series, No. 12, November 3 2022). Northern Policy Institute. Retrieved from https://www.northernpolicy.ca/upload/documents/nrs-series/nation-rebuilding-series_v12_2022-11-03.pdf