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Driving the Uptake of Geothermal Direct Use in New Zealand: Successful Strategies, Empowered Champions, and Lessons Learnt Along the Way

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ABSTRACT

New Zealand is on a positive trajectory, increasing the direct use of geothermal energy. The deliberate and coordinated efforts of a passionate group of geothermal advocates is providing a driving force for this growth. The past decade in New Zealand has seen new geothermal direct use developments establish, including timber processing and drying, glasshouses, minerals extraction and milk drying. There has also been some reduction in use such as with the closure of some operations at the Norske Skog Tasman pulp and paper mill at Kawerau in January 2013.

The geothermal industry, government, Māori, researchers and communities are aligned; geothermal direct use has significant potential to drive economic development and create jobs from this low-carbon energy source. New development could be stimulated as the geothermal energy available for direct heat use continues to far outweigh demand for uptake. A step-change in New Zealand's approach to increasing geothermal direct use was needed. Led by GNS Science, a group of geothermal advocates set out to achieve this change. Our goals were to create a sense of shared responsibility for mutual benefit, integrating sectors, organisations, and disciplines. Future growth would be underpinned by sustainability principles with an initial focus on commercial and industrial scale use from the higher temperature Central North Island geothermal resources.

A vehicle for achieving those goals is the Geoheat Strategy for Aotearoa New Zealand 2017-2030, which is a cross sector initiative fostering the direct use of geothermal energy. This industry-owned, and New Zealand Geothermal Association-led, strategy complements and aligns with the goals and aspirations of central, regional and local government energy and economic development strategies. Funding was secured to support a dedicated Geothermal Business Development Lead to drive prioritised actions. Volunteers formed an Action Group and are coordinated and empowered to act.

This paper discusses the development and implementation of initiatives that are strategically driving growth in direct geothermal use in New Zealand. We share our journey, ideas, successes and lessons learned.

1. INTRODUCTION

A coordinated effort is underway in New Zealand, driven by the Geoheat Strategy for Aotearoa New Zealand 2017-2030 (Climo et al, 2017) to increase the direct use of geothermal energy. Actions associated with the Geoheat Strategy seek to:

1. Unlock potential - so more of New Zealand's heat energy needs are met from renewable geothermal sources;
2. Contribute to economic and social development in regional New Zealand - increasing direct geothermal energy utilization, associated jobs and employment; and
3. Further increase low carbon energy use - assisting New Zealand to meet its 2030 greenhouse gas commitments to reduce greenhouse gas emissions to 30 per cent of the 2005 levels (United Nations, 2015).

There are a number of stakeholders involved in the implementation of the Geoheat Strategy that are discussed in this paper. To assist in clarifying the role, function and affiliation of each stakeholder, refer to Figure 1. The affiliation groups are Māori, Industry, Research Organisations and Government (Central, Regional and Local) and these are all shown as an ellipse in Figure 1. Stakeholders are placed within each ellipse based on their affiliation. Stakeholders with multiple affiliations are shown in places where the ellipses overlap. Stakeholder acronyms are used in Figure 1 for brevity; please refer to the Glossary of Acronyms in Table 3 (Section 8).

This paper contextualises the development of the Geoheat Strategy by providing background to Central and Regional Government strategies and initiatives in energy, identifying aspects that are applicable to increasing the direct use of geothermal energy. The role of economic development in regional New Zealand is also explored, which has seen regional and district economic development agencies, the Bay of Connections (BoC) and Enterprise Great Lake Taupō (EGLT), focus on high temperature geothermal resources as an enabler in their central north island areas of influence (Figure 2). Industry participation has also been critical to success; the New Zealand Geothermal Association has invested in developing the Geoheat Strategy and action initiatives coming from that strategy. Contact Energy Ltd and Ngati Tuwharetoa Geothermal Assets (NTGA) are actively pursuing supply of geothermal energy to businesses interested in directly using geothermal energy. The way these groups have invested in successfully fostering the uptake of the direct use of geothermal energy are described in this paper.

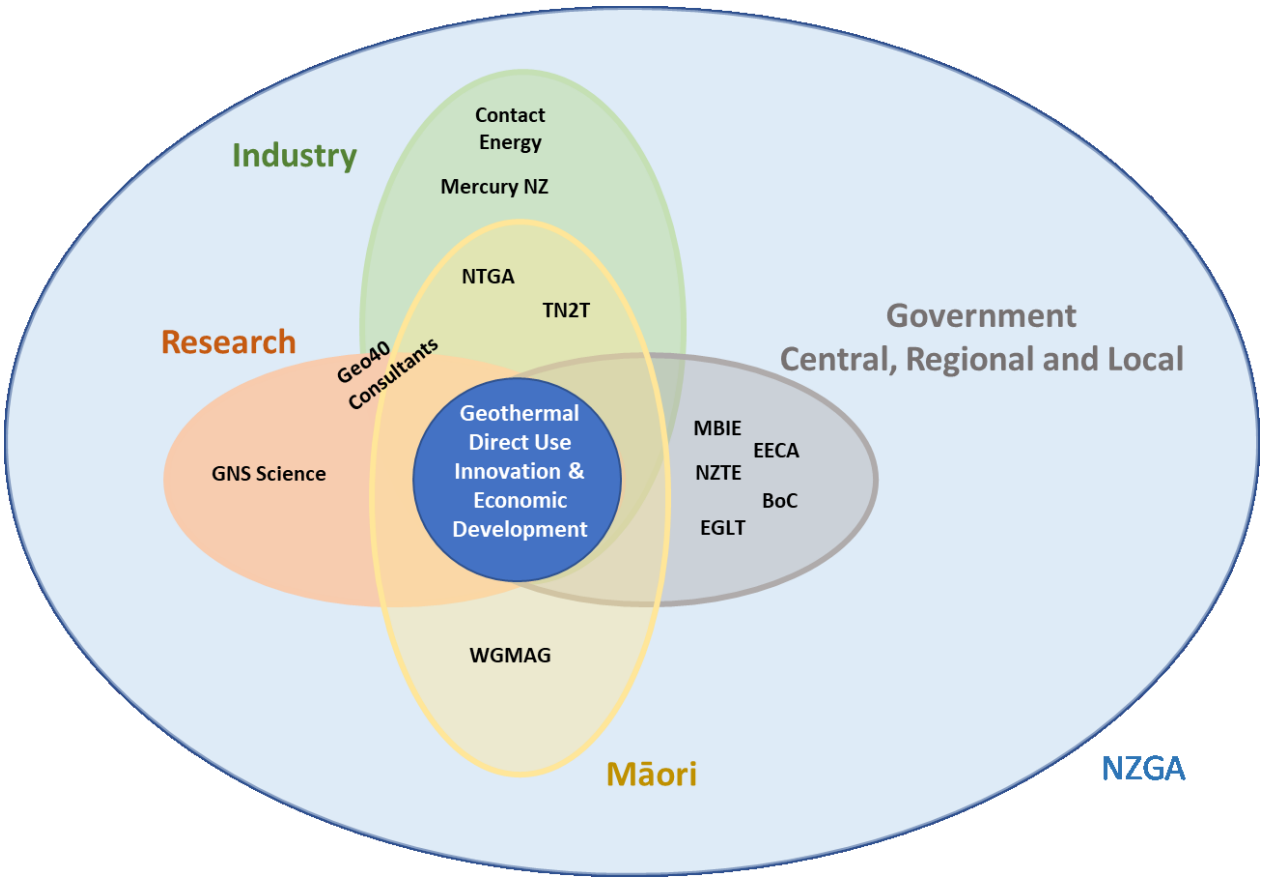

Figure 1: Stakeholders and affiliations. Some stakeholders have multiple affiliations and they are shown where the coloured ellipses intersect. Acronyms explained in Table 3 (Section 8).

2. NATIONAL ENERGY STRATEGIES

In the late 1980's the New Zealand government moved from being an active investor in energy infrastructure, to taking a monitoring and advisory role, along with being the energy sector regulator. The adoption of the free market approach to energy markets, under regulatory control, sees decisions and opportunities taken by individuals, businesses, investors, and communities determining the country's energy future.

As part of the approach, central government energy strategies have been developed that are high level and non-mandatory; three key strategies that are relevant to the direct use of geothermal energy are discussed in the sections that follow.

2.1 New Zealand Energy Strategy

The New Zealand Energy Strategy 2011–2021 (NZES) (MBIE, 2011) sets the strategic direction for the energy sector with a goal of releasing the energy potential for the benefit of the nation's economic wellbeing. The four priority areas are:

1. Diverse resource development (including renewable energy)
2. Environmental responsibility
3. Efficient use of energy
4. Secure and affordable energy

Geothermal Energy is noted in several places in the NZES (MBIE, 2011), for example:

> "We are fortunate to be blessed with abundant energy resources - … We are a world leader in geothermal energy." (p1)
>
> "We have extensive renewable opportunities. Our geography and climate provides us with …access to geothermal energy." (p2)
>
> "We are investigating ways to support the use and development of geothermal energy" (p6)…."The Government will prioritise research funding to areas based on New Zealand's resource strengths and unique characteristics, and where there is commercial potential." (p7)

The NZES sets an energy target for geothermal and woody biomass energy use of an additional 9.5 PJ per year by 2025 from a 2005 base (p18), the proportion between the two energy sources is not specified.

2.2 New Zealand Energy Efficiency and Conservation Strategy

The NZ Energy Efficiency and Conservation Strategy 2017 – 2022 (NZEECS) (MBIE, 2017) is interlinked with the NZES. It is led by the Energy Efficiency and Conservation Authority (EECA) with a focus to unlock New Zealand's energy productivity and renewable energy potential by encouraging businesses, individuals, and public sector agencies to take action to leverage NZ's renewable advantage. The goals not only focus on renewable electricity generation, but also on energy-saving and fuel-switching opportunities in other sectors. NZEECS is expected to contribute to transitioning New Zealand to a lower carbon emission economy, assisting to meet the 2030 climate change emissions targets.

In the context of the NZEECS with a scope that excludes consideration of on farm agricultural emissions, the Minister of Energy and Resources stated "Our greatest potential to reduce carbon lies in our process heat sector for industrial and commercial users, and in our transport sector; both have a much larger proportion of non-renewable energy than electricity" (MBIE 2017).

Renewable and efficient use of process heat is the most relevant NZEECS priority for direct geothermal energy use, with a target (developed using MBIE and Statistics New Zealand data) of a decrease in industrial emissions intensity[1] of at least 1% per annum on average between 2017 and 2022.

Opportunities to unlock energy productivity and renewable potential exist across the economy with solutions anticipated to require coordinated cross-cutting actions across sectors.

2.3 Process Heat in NZ (PHiNZ) Initiative

This central government initiative is led by the Ministry for Business Innovation and Employment (MBIE), supported by EECA and focussing on thermal energy use in industry where process heat accounts for 34% of NZ's energy consumption. Opportunities exist to decrease carbon emissions because over 50% of process heat demand is supplied from fossil fuels, mainly coal or natural gas.

Viable opportunities for some process heat users to reduce emissions already exist and can be deployed in short timeframes, however, impediments to adoption of these technologies are at times real and for rational reasons some of the users do not enact the emissions reduction opportunities. Capital available for energy transition is a key aspect constraining energy and efficiency investment decisions by large process heat users (PwC, 2018). While a business case for investment in energy efficiency can often be made, business decision-making processes do not necessarily consider it as the best or optimal outcome to the point that even when energy efficiency opportunities passed cost-benefit tests they did not pass prioritisation when put up against non-energy capital projects (PwC, 2018).

MBIE and EECA are looking for process heat emissions reductions achieved through two means: (i) improving the energy productivity of existing processes, and (ii) fuel switching (i.e. increasing the proportion of renewable energy used to supply heat). An action plan for optimising process heat commenced development later in 2018. This plan will investigate whether there are market failures that are preventing increased efficiency and use of renewable energy for process heat. It also aims to include policies, programmes and suggested actions to increase the use of renewable energy by businesses and public sector agencies, and improve the efficiency of energy intensive processes. A technical paper on process heat in New Zealand was publicly released in early 2019 (MBIE, 2019), along with a series of supporting fact sheets (MBIE, 2018).

3. REGIONAL AND DISTRICT STRATEGIES

In parallel to the central government energy strategies, regional and district economic development agencies in the Taupō Volcanic Zone (Figure 2) identified geothermal energy, and specifically direct use, as a unique offering with significant potential for positive economic and social impact on the communities that reside near geothermal resources.

3.1 Bay of Connections

The Bay of Connections supports strategies that encourage economic growth in the Bay of Plenty Region and the Taupō District. In December 2011, BoC launched an Energy Strategy (BoC, 2011) outlining a spectrum of potential energy opportunities including geothermal energy as a key focus. In 2016 an update to the Energy Strategy (BoC, 2016) was released, outlining a vision to create wealth and wellbeing through renewable and sustainable energy, by creating sustainable new business growth opportunities and employment.

> "The region's existing renewable energy industries and generators – including those who are literally generating their own steam for manufacturing and production purposes – can be leveraged to create ecosystems and business clusters" (BoC, 2016).

Importantly, BoC established a Geothermal Business Development Lead (BDL) in December 2017 to foster the uptake of direct geothermal use. This is discussed further in Section 4.

3.2 Enterprise Great Lake Taupō

The Taupō community has been involved in the geothermal sector since the Wairakei geothermal power development in the 1950's. EGLT is the economic development agency for the Taupō District, which includes the townships of Taupō, Turangi and Mangakino. Its aim is to enrich the community through the creation of wealth and jobs for the district by working with business.

[1] Emissions intensity is defined as kg CO2 equivalent emitted divided by the Real Gross Domestic Product (GDP)

The 2012, EGLT strategic plan identified ‘Adding Heat to Primary Product’ as one of four key focus areas (EGLT, 2012). Actions included identifying large scale opportunities involving geothermal use, developing feasibility studies on these opportunities and investigating heat parks as a concept.

Taupō District’s 2018 Economic Strengthening Plan identified geothermal as one of six key projects to help achieve its mission “to be the most prosperous and liveable district in the North Island (NZ) by 2022” (Taupō District Council, 2018)

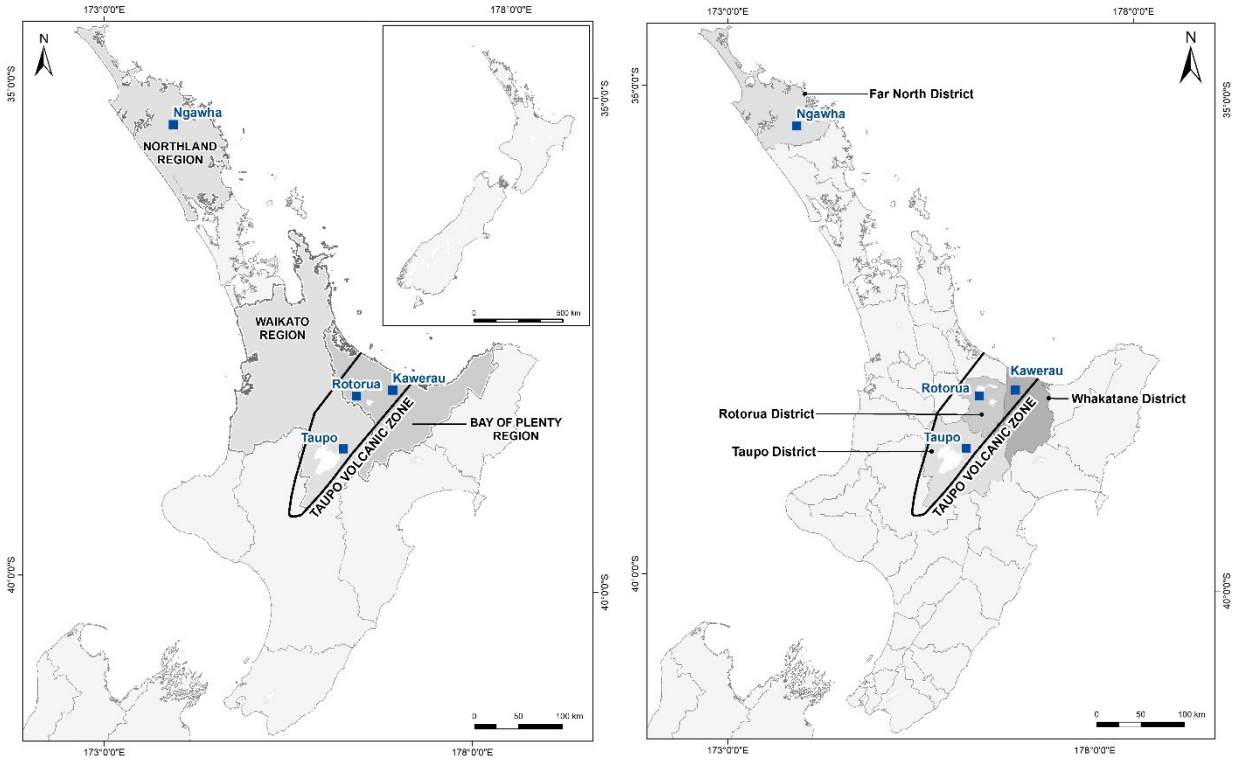

Figure 2: (a) Three Regions with high temperature geothermal resources; Northland Region contains the Ngawha geothermal resource, and the Taupō Volcanic Zone resources reside in the Waikato and Bay of Plenty Regions; (b) Districts containing high temperature geothermal fields.

3.3 Māori STEAM Strategy

While there are many geothermal assets in the Bay of Plenty and Taupō areas, a number of which are Māori owned, there are relatively few Māori directly employed in the geothermal sector. To respond to this and other challenges, and to better leverage the economic benefits for Maori, in 2013 BoC developed a Māori economic development strategy ‘He Mauri Ohooho’ (BoC, 2013).

In 2017, the Kaihautu Ohanga Māori (Bay of Plenty Maori Economic Development Navigator) led a refresh of the strategy and began focussing on connecting rangatahi (the younger generation) with industry. Dr Riri Ellis, He Mauri Ohooho chairwoman stated on 29 September, 2017 that "Seventy-five percent of the region's (Bay of Plenty) Māori population are under 15. We need a strategy that grows both our people and our region. We need to connect them with higher skilled job opportunities as they start opening up” (Bay of Plenty Times, 2017).

A Māori STEAM strategy and action plan has been developed, whereby Māori in the Bay of Plenty are accelerated into higher value job opportunities (http://www.toikairawa.co.nz/). Opportunity arising from growing geothermal direct use is one of the targets of this STEAM strategy. The strategy was launched in September 2019.

4. DEVELOPING A GEOHEAT STRATEGY FOR NEW ZEALAND

New Zealand’s direct geothermal energy use had developed over a period of more than fifty years in an ad hoc manner and without an overarching strategy. There have been successes through this approach, including establishing the large direct industrial geothermal heat use at Kawerau for timber drying, and pulp and paper processing in the 1950’s. New Zealand has a wide diversity of uses, including bathing, timber drying, milk processing, aquaculture, and green-housing but without strategic direction and coordination, direct use had seen periods of growth, of little or no change, and decline through various periods of time; influenced by market economics, product positioning, company strategies and some government intervention (Climo et al, 2016b).

In 2012, staff from GNS Science identified that a strategy was needed to address these issues (Carey and Climo, 2012). The Strategy would provide the opportunity for coordination, be directive, whilst actively involving stakeholders and the geothermal community in its implementation. The New Zealand Geothermal Association (NZGA) was identified as the appropriate organisation to host the Geoheat Strategy.

The New Zealand Geoheat Strategy aims to foster sustained (and sustainable) growth, realise untapped potential, and play an important part in New Zealand’s renewable energy future. It targets some 7,500 TJ/year of additional primary geothermal energy that

could be accessed for industrial / commercial use, which if connected to businesses, could grow New Zealand's direct use by about 40% (Climo et al., 2016b) by 2030. Importantly employment would be associated with this growth in geothermal energy utilisation.

The two subsections that follow identify the process used to develop the strategy, and its focus.

4.1 Strategy Development Process

Early 2015 saw development efforts commence through a project led by GNS Science, using a consultative process seeking to ensure the Strategy would be robust and widely supported. A systems mapping exercise identified key influences and success factors for increasing the direct use of geothermal energy in New Zealand. Facilitated focus group workshops were then held with stakeholders (e.g. central, regional and local government, economic development agencies, industry, researchers, Maori) to seek feedback on these factors, to generate ideas on possible impediments to uptake and to identify possible actions to take to reduce or overcome these. Material was presented back to the geothermal community through papers and presentations (Climo et al., 2016a; 2016b), consultation at conferences, and through the NZGA website.

Maori consultation was undertaken through the Waiariki Geothermal Maori Advisory Group (WGMAG). This group were supportive and the chair of the group wrote a forward to the Geoheat Strategy document. A draft document was prepared in 2016 and following public feedback the document was finalised in 2017. A launch video was prepared (NZGA, 2017) and the Geoheat Strategy (Climo et al., 2017) was formally launched at a New Zealand Geothermal Association Workshop (27th June 2017).

4.2 GeoHeat Strategy Focus

The Strategy is based on four underlying principles (Figure 3, outer ring):

1. **Kaitiakitanga**: Geothermal development is founded on sustainable business and resource use models, recognises kaitiaki, and supports current and future generations
2. **Shared**: Strategy responsibility is shared, information will be open and benefits will be mutual
3. **Integrated**: Sectors, organisations and disciplines support and complement each other in the pursuit of a common goal
4. **Focused**: Our focus is direct use growth, building on strengths and current successes, to deliver maximum benefit to New Zealand

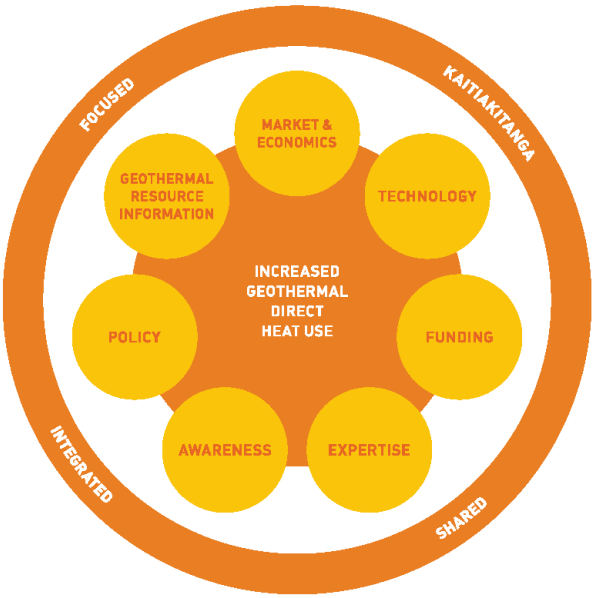

Figure 3: Four underlying principles of the Geoheat Strategy in the outer ring and seven enablers (Climo et al, 2017).

The Strategy was deliberate in initially focusing on direct geothermal heat use in the commercial and industrial sectors in Northland, Waikato and the Bay of Plenty Regions (Figure 2), as these sectors were expected to have the greatest energy use and job growth potential. The goals of the Strategy are to enable an increase in direct primary geothermal energy use of 7.5PJ (7.5 x 10^{15} joules) by 2030 (from 2017) and facilitate an increase in employment associated with this energy use by 500 jobs.

The strategy proposes a coordinated approach to the key action areas identified in the yellow circles in Figure 3, including:

1. Increased Government, industry and other sector investment in geothermal projects;
2. Greater awareness of geothermal opportunities;
3. Promoting best practise application of technologies;
4. World-leading capability and expertise is retained and accessible;
5. National, regional and district level policy are aligned and supportive;
6. Data is accessible on geothermal resources and uses; and
7. Geothermal advantages are integrated in business structures and economic data is accessible.

It intends a shared responsibility that integrates sectors, organizations and disciplines for shared benefit. It is about marketing beyond the geothermal sector, to businesses that could benefit from using geothermal energy directly, fostering uptake, including assisting

businesses in developing business cases around geothermal direct use in the broadest sense. The work is front footing, raising the profile of direct geothermal energy use, mobilising interest, overcoming impediments, providing connections, coordinating and driving for uptake.

5. GEOHEAT STRATEGY IMPLEMENTATION

The Strategy document identified five key actions necessary to build the foundation for successful implementation. These were successfully completed in 2017/18.

1. A Strategy Governance Group was established
2. A Geothermal Business Development Lead (BDL) was appointed (A.Blair) and resourced for an initial term of 2 years, funded by a collective of government (MBIE), regional economic development (BoC), NZGA and industry funding. The coordination of the Strategy would be led by the BDL.
3. A Geoheat Action Group was established
4. A 'virtual' direct use hub was established as an online presence through the NZGA
5. The first Action Plan was developed, for the 2018–2019 period (Climo et al., 2018)

5.1 Key Roles for Implementation

The NZGA as strategy host appointed a governance group in 2018 to provide project oversight and governance functions for the work. Membership in the governance group comprises expertise in economic development, Maori and industry perspectives, and planning and regulatory considerations. The group provides their time voluntarily for two meetings per year to keep the Strategy work connected to the NZGA. The role of the Governance Group is to:

1. Provide advice and direction to the BDL;
2. Provide regular reporting to the NZGA Board;
3. Direct and participate in strategy effectiveness reviews and respond to review outcomes as necessary;
4. Coordinate and align with regional economic development programmes;
5. Establish and maintain connections into Central Government; and
6. Set a long-term vision for direct geothermal use in New Zealand and track progress towards achieving this.

The BDL was seen as a vital role to activate the strategy to work with different organisations, including industry, iwi and others, to connect parties, assist with development of business cases and encourage investment in direct use geothermal opportunities through the period of 2018 and 2019 being the initial BDL contract period.

The Geoheat Action Group was established in early 2018, it meets six times per year to share achievements, to discuss the next steps, to share areas where others might support activity, be inspired and be a forum to discuss sector issues. The group has about 20 active participants with all time and resources put into the Action Group being on a voluntary basis. With voluntary input, activity occurs where people are interested and willing to put in their time and resourcing.

5.2 Geoheat Action Plan

The intention is to produce a targeted action plan under the umbrella of the Geoheat Strategy every 2 to 3 years, to ensure that activity under the Strategy is regularly reviewed and remains effective. The 2018-19 Action Plan (Climo et al., 2018) identified an overarching objective of three new medium to large scale (minimum 30 jobs) direct geothermal projects committed and under development by December 2019.

Four key priority actions, to be driven by the BDL through 2018 – 2019 were:

1. Develop a stocktake of supply side assets, infrastructure and geothermal resources to create a communicable picture of geothermal opportunities in New Zealand.
2. Target commercial and industrial scale projects on brownfield sites where geothermal capacity exists.
3. Undertake domestic and international market analysis for large heat users.
4. Develop market value propositions for geothermal heat suppliers.

In support of these key priority tasks, the Geoheat Action Group were to advance a range of other complementary activities, including growing networks to raise the geothermal profile, engaging key expertise and showcasing success stories to increase awareness and stimulate further development.

6. SUCCESS STORIES

6.1 Networking and Raising the Geothermal Profile

Outside of the geothermal industry there is limited understanding about what direct geothermal use is. To address this, there has been a focus on communicating the benefits derived from new and existing projects, such as the levels of employment, the environmental benefits, the benefits of using renewable energy and associated product credentials. Often, businesses and their customers are less interested in geothermal energy per se, but they do care about sustainable energy that it is economically competitive and good for business.

One of the most effective means of raising the profile of geothermal energy in New Zealand has been to present to or attend non-geothermal industry and sector conferences. Additionally, a group of process engineers from the Institution of Chemical Engineers have been hosted by NTGA on a site visit to direct use facilities at Kawerau. Members of the action group, and wider geothermal community, have leveraged existing events, targeting industries where there is an energy demand, and events attended by target

sectors/roles (e.g. planners, design engineers) whose behaviour we want to change to consider geothermal energy in their decision making.

Representatives from Mercury NZ Ltd, Contact Energy Ltd, Ngati Tuwharetoa Geothermal Assets, and Tauhara North Number Two Trust, along with the BDL formed a Direct Use Group, whereby discussions were held on their interests, insights and potential opportunities to work together. This forum also provided a platform to update on activities and for them to provide advice and ideas for BDL workstreams.

Engaging with central government economic agencies such as New Zealand Trade and Enterprise (NZTE) and MBIE to gather business market intelligence, connect with existing networks and activities and utilise skilled business case writing and market experts has provided support and insight, whilst providing a platform to promote geothermal energy to the international and domestic investment sectors.

In July 2019 an informal global network was established by the BDL, whereby country leaders in geothermal direct use can connect for the purpose of sharing communications, insights, information, advice and support.

6.2 Positioning for Success

A number of activities led by the BDL were aimed to better position the direct use geothermal sector for successful development growth. Effort was focussed on identifying targets and leveraging networks to identify specific industries, investors and potential partners that could directly use geothermal resources as part of their business. Market value propositions were developed, and effort was made to support pitching the value of geothermal heat and what it could offer to domestic and international businesses. Central government support mechanisms and resources were accessed as appropriate to, for example, provide seed funding or advice.

6.3 New Businesses Leveraging Geothermal Energy

A diverse collection of direct use geothermal projects on existing brownfield sites across the Taupō Volcanic Zone are now underway, including projects in computing, food and beverage, tourism, nutraceuticals, wood processing and dairy processing. Table 1 provides some examples of these with the sections that follow providing additional details. These projects have all commenced since the Geoheat Strategy was launched, but not all have occurred due to activity directly associated with the BDL or the Geoheat Action Group.

Table 1: Examples of businesses in the central North Island utilising or setting up to utilise geothermal energy as part of their business operations since late 2017.

Business Name & Geothermal Field	Activity	Size of Operation	Geothermal Energy Use & Supplier	Projected FTEs*
The Rogue Bore Brewery [Wairakei]	Brewery	$5M capital investment. Capacity to brew 1.8ML beer per year	3 MW geothermal heat supplied by Contact Energy	~24
GEO40 [Ohaaki]	Silica extraction	$15M capital investment. 10,500 tonnes a year of silica extracted	~6700 tonnes per day of geothermal fluid supplied by Contact Energy	~30
Waiū Dairy [Kawerau]	Milk processing	$33M capital investment. One tonne per hour dryer processing 30ML/year of milk	20 MW geothermal heat supplied by Ngati Tuwharetoa Geothermal Assets	~40
Nature's Flame [Tauhara]	Wood pellet productions	Capital cost $34M + cost of conversion to geothermal. 40,000 tonnes of wood pellets produced per year	20 MW geothermal heat supplied by Contact Energy	~50

** FTEs = Full Time Equivalents. These numbers include all people working onsite at the operation, and excludes suppliers of steam and other contractors e.g. maintenance etc.*

Rogue Bore Brewery will be New Zealand's first Carbon Zero brewery, producing beer that is brewed and carbonated using 100% geothermal energy and showcased to the world through an industrial tourism experience. The brewery is being established in the Wairakei Geothermal Steamfield with first production planned for early 2020. This is a specialist craft brewing operation with tourist operations and a restaurant in the heart of a geothermal steamfield. Named after the famous 'Rogue Bore' a geothermal bore that exploded in 1960 creating a crater 22 meters deep and 70 meters long. The explosion sent a plume of steam visible 120km away with the resultant geyser becoming a tourist attraction until the mid-1970's when it died down naturally. Beer names (e.g. Figure 4) include Pipeline, Big Bore, Baseload and Go Devil.

Figure 4: Proposed Rogue Bore Brewery product

Geo40, in cooperation with Contact Energy and the Ngati Tahu Tribal Lands Trust, is expanding from a commercial demonstration plant to a larger production operation for the extraction of silica from geothermal fluid. On 9 July 2019, Regional Economic Development Minister Shane Jones announced central government's investment of NZ$15M to assist with building a larger commercial production plant (Jones, 2019). The operation will see Geo40 use its technology to extract silica from geothermal fluid at Contact's Ohaaki facility. The extracted silica will be sold for use in consumer goods such as paint, tyres, etc providing an environmentally-sound source of silica that would otherwise require carbon-intensive energy to produce. This commercial plant follows the success of the demonstration plant and will see Geo40 process 6,700 tonnes per day of separated geothermal water.

Waiū Dairy operation (Figure 5) is designed to produce specialty, high value cow and organic cow milk products such as milk protein concentrate (MPC), organic milk powders, organic MPC, milk protein isolates, cream processing and butter production. Geothermal Energy supplied by NTGA is used in the process, particularly for drying. The initial drying capacity installed is one tonne per hour, with the plant set up to batch process different types of milk. The plant is to be certified organic to US National Organic Program standards. CEO Richard Jones reported "We believe there are some emerging opportunities for a processor of our size to look at specialist milk types – sheep and goat and plant-based 'milks'. We expect to be seriously considering further expansion of our facility within three years." (Dairy News, 2019). The site blessing occurred on the 20th March 2018, construction is well advanced with operations expected to commence later in 2019.

Figure 5: June 2019 Waiū Dairy Powhiri (POUTAMA 2019).

Nature's Flame is an established Taupō business that takes wood shavings and sawdust from the timber industry. The material is screened, dried on a belt drier (Figure 6), ground to size and pelletised in a high pressure die. The pellets are used in biomass boilers with sales to both domestic and international customers. The company established it's Taupō operation in 2010; in 2019 the plant was modified to utilise geothermal heat to dry the pellets. Contact Energy supplies the heat from wells in the Tauhara geothermal field. The geothermal heat supply replaced an undersized biomass boiler enabling the facility to more than double production.

Figure 6: Nature's Flame Wood Shaving and Sawdust Belt Drier(s) converting to geothermal energy. Photo credit: Brian Carey, GNS Science.

7. KEY LEARNINGS

The development of the New Zealand Geoheat Strategy and its subsequent launch, successful implementation and release of its first targeted action plan has produced a range of key learnings that may be of interest to other nations seeking to maximise their geothermal potential.

7.1 Prioritise

A successful strategy leverages strengths to seize opportunities, however focus is necessary to maximise the value of effort to deliver rapid outcomes. A key strength of the Geoheat Strategy to date has been the approach to identity and focus on a low number of high impact actions.

Key learnings on prioritisation when developing and implementing strategies to grow geothermal direct use include:

- Prioritize now, but keep the future in mind
- Remember that strategy implementation is a journey, not a destination
- Focus on establishing an enabling framework, not on a rigid plan
- Be agile and adaptive - if an idea is volunteered move with it and take it up. With the volunteer comes resources.
- Don't start from scratch; connect with others and utilise their resources and insights

The stakeholder consultation undertaken during the strategy development process resulted in a list of possible actions and activities that would all play a part in changing behaviour, and ultimately, assisting to increase the use of geothermal energy. It was not practical, nor affordable, to undertake them all and nor did all the activities provide the same cost/benefit. Prioritisation (e.g. Table 2) was essential to ensure that progress was made, and that actions were advanced for maximum impact in a strategic manner.

Table 2. Priority actions defined in the 2018 -2019 Geoheat Action Plan (from Climo et al., 2018)

<table>
<tr><th colspan="2">Primary Focus</th></tr>
<tr><td colspan="2">• Brownfield developments
• Industrial and commercial scale
• Stocktake (supply side)
• Market value proposition (market side)
• Identify targets and connect large heat users/suppliers
• Use central government support mechanisms and resources to attract and convert investment</td></tr>
<tr><th>Secondary Focus</th><th>Out of Focus</th></tr>
<tr><td>• Advocate for support of direct use geothermal
• Showcase direct use geothermal</td><td>• Greenfield developments
• Residential scale use
• Heat Pumps
• Education/Advice</td></tr>
</table>

7.2 People Power

A Strategy of this type relies on the energy, enthusiasm and expertise of a wide range of people to develop and deliver it. Key learnings on people included:

- Form the best team – a small, focussed leadership team is key
- Energize others to be empowered to act – the core leadership team can't do everything and be everywhere
- Find and empower champions in key arenas (e.g. government, industry, demand sectors)
- Resource it well – find funding, leverage mutual interests and use volunteers

Delivering on the Strategy has benefited from having the right people, in the right place, at the right time. But this has not been down to luck, it was deliberately crafted (substantially) by securing resources and making connections.

Working collaboratively with government agencies (central, regional and local) and industry resulted in funding support for the BDL for 24 months. This was because the goals and initiatives of identifying and engaging with potential geothermal heat users domestically and abroad overlapped central and regional development aspirations.

Cross sector links and relationships were established and capitalised on. The networks of NZTE for instance were leveraged to identify industries, investors and potential business partners that might directly use geothermal resources as part of their business.

7.3 Partner and Use Networks

Many organisations have been involved to some degree. The established relationships and enthusiasm of key people were able to bring together industry, government, business, iwi and communities. The economic development agencies were the key partner to convince. These entities recognise geothermal energy as an asset for their region/local areas with significant and real potential for economic development growth.

Key learnings on partnerships included:

- Key relationships are everything – grow them, nurture them, expand them
- Leverage - look for synergies and mutual benefit
- Action requires resourcing - securing funding is tough so think creatively
- Don't give up – persevere!

One aspect of networking that has not been leveraged to any significant degree so far is media and social media; these platforms may offer additional ways to connect people, to inform and to spread key messages about the benefits of direct use geothermal energy.

7.4 The Approach

New Zealand's approach to economic development aims to boost regional prosperity by capitalising on local assets and added-value. Picking winners in business development is never certain and resources available to assess and invest in opportunities are limited, so an important aspect in developing potential new business ventures (or changes to the energy use of existing businesses) is to use speed in selecting and testing the opportunities; move fast and do not spend time on dead ends, move on.

Key learnings from the approach are:

- Pursue a small number of strong probabilities rather than many low-moderate possibilities
- Focus on growth products with large ready-made offshore market (no products that require legislative or building code changes, or could not be exported cost effectively)
- Seek net creation of jobs and industry
- Attract commercial partners
- Attract foreign investment into the region

8. SUMMARY

It was recognised that the earlier ad-hoc approach to fostering direct geothermal energy use in New Zealand could usefully be augmented with improved coordination, prioritisation and marketing to businesses beyond the geothermal sector. Development and now implementation of the Geoheat Strategy for Aotearoa New Zealand is making this possible.

The Strategy is structured to deliver a step change in New Zealand's geothermal direct use. It does not stand alone, but rather it exists in an ecosystem, overlapping and aligned with central, regional and local government economic development strategies, industry goals, and Maori aspirations and values. Integration and mutual leveraging provide a platform for success.

Key areas of action have been to better understand the resource / value proposition; analysis of market opportunities; connecting energy users and suppliers; and continuing to raise awareness of the benefits offered by harnessing geothermal energy for a range of business needs. The resourcing of the Geothermal Business Development Lead has been crucial in facilitating the growth that has occurred since the end of 2017.

Since that time New Zealand has seen the development of a number of new initiatives in the geothermal areas in the Central North Island, including project investment worth NZ$50M to 100M in total, employing >80 people and spanning a variety of industries including dairy processing, food and beverage, mineral processing, and wood processing.

Above all, the strongest driver to success has been the people. Leadership and coordination are essential to bring about change, and to benefit from the collaborative efforts of the wider geothermal community.

Table 3: Glossary of Acronyms

Acronym	Meaning
BDL	Business Development Lead
BoC	Bay of Connections
EECA	Energy Efficiency and Conservation Authority
EGLT	Enterprise Great Lake Taupō
MBIE	Ministry of Business, Innovation and Employment
NTGA	Ngati Tuwharetoa Geothermal Assets
NZEECS	NZ Energy Efficiency and Conservation Strategy
NZES	New Zealand Energy Strategy
NZGA	New Zealand Geothermal Association
NZTE	New Zealand Trade and Enterprise
PHiNZ	Process Heat in NZ Initiative
WGMAG	Waiariki Geothermal Maori Advisory Group

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