



ACTION PLAN 2022-2023

GEOHEAT STRATEGY FOR AOTEAROA NZ



FOREWORD

On behalf of the New Zealand Geothermal Association (NZGA), it is with pleasure that I introduce the Geoheat Action Plan for 2022 - 2023.

This Action Plan is the roadmap for Aotearoa New Zealand to further progress the uptake of geoheat for industrial and commercial process heat applications. As well as creating a shared vision and focusing efforts of the geothermal industry, it also highlights the benefits for broader industry and policymakers to support and tap into this uniquely New Zealand resource. For geothermal to realise its full potential in Aotearoa's net zero-carbon energy future, we must have a solid strategy to enable this. The Geoheat Strategy for Aotearoa NZ 2017-2030 does just this. It reflects the four key pillars of the NZGA's vision "Creating a sustainable future for Aotearoa New Zealand through geothermal" through connection, innovation, advocacy, and education. Through this Strategy and its Action Plans, we aim to see the uptake of geoheat enabling businesses to grow, economies to prosper and the regions to see the benefits of geothermal first-hand.

NZGA is proud to take a leading role in delivering the Geoheat Strategy. This Strategy seeks implementation of fuel-switching projects and new ventures in the short to medium term, by assisting businesses to use geoheat and thereby accelerate their move to low-carbon energy sources. Increased use of sustainable geothermal resources in Aotearoa New Zealand is a key outcome for the NZGA, and we aim to deliver to local, regional, and national targets for decarbonisation, infrastructure development, support of Māori economic prosperity, and workforce growth.

The Strategy is designed to be directive, yet flexible, incrementally evolving as efforts reveal the next best steps in rapidly changing business and energy sectors. The 2020-2021 Action Plan was not all smooth sailing; the Covid-19 pandemic and conclusion of funding for the Geothermal Business Development Lead (BDL) affected

but did not fully derail progress. There were noteworthy accomplishments during the same period, including over 20 business cases being developed, submitting to the MBIE Accelerating Renewable Energy and Energy Efficiency discussion document, showcasing career and geoheat opportunities in both Kawerau and Taupō, and highlighting geoheat success stories on the global stage at the World Geothermal Congress (Iceland, 2021).

I want to thank the Bay of Connections, MBIE and our geothermal industrial contributors for six months of funding for the Geothermal BDL role in 2020, and to Amplify for funding a Geothermal Cluster Lead for 2021. These business development roles have been, and will continue to be, instrumental in raising the visibility of geothermal resource use. Dedicated roles such as these are vital for connecting businesses with geoheat opportunities, which we are confident will bring new developments in the very near future.

Working with our partners, we will continue to drive and champion the Strategy for the benefit of all New Zealanders. Please join with the NZGA, to share in this vision, and dedicate time and resources to actively grow geothermal process heat use for the future prosperity of Aotearoa New Zealand.

E koekoe te tūi, e ketekete te kākā, e kūkū te kererū
The tūi chatters, the kākā cackles and the kererū coos.
All the different birds together make the forest song.
It takes all kinds of people to make things work.

Dr. Paul Siratovich
Chair - Geoheat Strategy Governance Group
President - New Zealand Geothermal Association



REALISING GEOTHERMAL POTENTIAL

EXECUTIVE SUMMARY

To meet the 2030 Nationally Determined Contribution carbon target, and the 2050 net zero carbon target, Aotearoa New Zealand must transition away from fossil fuels, with a range of renewable energy sources needed to support decarbonisation.

Local sustainable geothermal energy solutions have been decarbonising the nation’s energy use for over sixty years, enabling industries to thrive and regions to flourish while also supporting Māori socio-economic development. New Zealand is a world-leader having one of the largest developed geothermal industries in the world, with the fifth largest installed generation capacity. In addition to generating electricity, developed geothermal resources provide low-carbon, sustainable, reliable, off-grid heat energy for industry. New Zealand has the highest use of geothermal process heat by industry. At both the resource and technology levels, geothermal process heat (“geoheat”) is well proven, with additional capacity available right now to be more widely deployed. Geoheat is already powering: wood processing, food and beverage manufacturing, dairy processing, timber drying, horticulture, aquaculture and biotechnology businesses, and is also relevant to any industry that uses heat from chilled temperatures (4°C) up to 220°C.

This Geoheat Action Plan is the third in a series advancing the Geoheat Strategy for Aotearoa, 2017-2030. The Strategy and Action Plans focus on the direct use of geoheat for industrial and commercial scale projects in particular from the established higher temperature geothermal resources in the central North Island, where geoheat is a well-established energy option.

This latest Action Plan identifies six priority Actions for the 2022-2023 period; to Communicate, Advocate, Showcase, Represent, Partner and Advance geoheat. These integrated and mutually-reinforcing priorities are intended to deliver two objectives of raising awareness of geoheat opportunities and converting business interest

into tangible development projects.

The effectiveness of the previous Action Plan through the 2020-2021 period is also reviewed, and two geothermally-heated wood processing operations are showcased. By sharing lessons learned and raising the profile of geothermal process heat advantages and opportunities, future projects can learn from and build on past successes.

This document is not intended as a repository for all the evidence and case studies supporting geoheat as a viable, bankable low-carbon energy solution. A wealth of publicly available information on this is already shared by the NZGA and associated organisations. That said, one of the priority actions of this Action Plan is to prepare and make available more case studies and success stories.

Geothermal is Aotearoa New Zealand’s heritage, a crucial energy source today, poised to play an even greater role in our low carbon energy future. With a focus on supporting commercial and industrial process heat users, whether they are fuel-switching to renewables or establishing new ventures, increasing geoheat use is a multi-stakeholder initiative relevant to decision-makers looking for low-carbon energy. This Action Plan is intended for use by national, regional and local government decision- and policy-makers, consultants, investors, funders and, most importantly, end-users; industries and businesses that are looking for a sustainable, cost-effective source of low-carbon heat.

We invite you to join us in Aotearoa New Zealand’s geoheat future; positioning geoheat top-of-mind as Aotearoa New Zealand’s cost effective, low-carbon energy option, and by delivering at least five new projects by the end of December 2023.

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- GNS Science's research programme "New Zealand's Geothermal Future" for financial support towards the ongoing organisation of the Geoheat Action Group, and design and publication of this 2022 – 2023 Action Plan.
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WHY GEOTHERMAL?

Geoheat is geothermal energy used as process heat.

Direct Geothermal Use or Direct Use refers to the use of geothermal energy or fluid directly. Essentially an application using geothermal energy for a purpose other than generation of electricity.

Beyond electricity generation, geothermal resources support process heat operations across a range of scales and temperatures, particularly from developed reservoirs in the Taupō, Rotorua and Kawerau Districts. Geoheat offers a uniquely Aotearoa New Zealand process heat option that is:

- **RENEWABLE** – Geothermal energy is renewable energy, recognised as such in New Zealand law (RMA 1991). Sustainable management of geothermal energy resources provides an underpinning ethos for businesses seeking to future proof energy supply with sustainability credentials.
- **LOW CARBON** - Life cycle analysis (LCA) shows geothermal is on par with the carbon intensity of other renewables available in Aotearoa New Zealand.
- **COST EFFECTIVE** - Geoheat is supplying delivered energy at about \$10 / GJ (including the cost of carbon). This is cheaper than other renewable options and fossil fuels.
- **AVAILABLE** - Commercial and industrial energy can be delivered from established geoheat suppliers with lead times as short as 12 months.
- **PROVEN AT SCALE** - Geoheat resources and energy use has been proven at individual supply scales at capacities up to 100 MWth, supplying ~3PJ of energy per annum.
- **LOW RISK** - Geoheat has been used in New Zealand for over 60 years, and is backed by a wealth of established engineering expertise able to support plant design, installation, maintenance and operation.

Since the 1950’s, geoheat has offered New Zealand low-carbon energy. Enthusiastically embraced by the timber and pulp & paper industries (e.g. Norske Skog Tasman, Carter Holt Harvey, Essity, Tenon, Oji Fibre Solutions, Sequel Lumber), geoheat is also used for greenhouse heating (Gourmet Mokai, 2002 and PlentyFlora, 2002), dairy processing (Miraka, 2010; Waiū Dairy, 2019), processing biomass (e.g. wood pellets at Nature’s Flame, 2019) and to free up biomass to decarbonise other processes (Oji Fibre Solutions, 2019). In addition to new ventures starting up with geoheat, successful industrial-scale conversions from fossil energy to geoheat have included Tenon (kiln drying timber, 2007), Essity (tissue production, 2010), and Oji Fibre Solutions (pulp production, 2019).

Throughout the geoheat strategy, geothermal is identified as a low-carbon renewable.

Aotearoa New Zealand is committed to decarbonising its energy sector and economy, and is rapidly moving away from fossil fuels, accelerating investment into renewables. Our challenge as a nation is to ensure an equitable transition as we utilise all our renewable energy resources, including geothermal energy. In this, the Geoheat Strategy is firmly aligned with the directions set by the Climate Change Response (Zero Carbon) Amendment Act 2019, advice to Government from the Climate Change Commission, local and regional economic development aspirations and with the revised Nationally Determined Contributions the New Zealand Government committed to in November 2021, when these were revised and announced at COP26 (Glasgow, 2021).

Our focus is to position geoheat to contribute to this low-carbon energy future.

Geothermal energy is renewable. Hot geothermal fluids brought up from the reservoir are used and then reinjected back into the reservoir, replenishing fluid back into the natural resource. Developed geothermal fields are carefully monitored and managed to ensure sustainable use. In Aotearoa New Zealand, a number of fields are operated in conjunction with local iwi, and the mauri principle of kaitiakitanga, or “guardianship”, is a value inherent in those geothermal operations.

While current geothermal operations do release some greenhouse gases, life cycle analysis (LCA), which includes materials, construction, maintenance and operation, shows geothermal is on par with the carbon intensity of other renewables available to Aotearoa New Zealand (Siratovich, 2021’).

Some of the naturally-occurring carbon dioxide and methane in solution in sub-surface geothermal fluid is released, as temperature and pressure reduce as the fluids are brought to the surface. Whilst utilising the fluids at surface a low level of greenhouse gas is emitted to the atmosphere. The geothermal industry is actively working

to further reduce the level of atmospheric emissions, moving geothermal operations towards zero operational carbon emissions through plant design, reinjection and carbon capture.

About 60% of process heat demand in Aotearoa New Zealand is supplied from fossil fuels, mainly coal or natural gas (MBIE 2019). Opportunities exist to decrease carbon emissions in existing process industries by conversion to geoheat. For example, the conversion of Tenon to geoheat from natural gas resulted in ongoing CO₂ emissions reduction of ~28,000 tonnes per year from their Taupō operation, and the Oji boiler conversion, showcased on page 16, resulted in annual emissions reductions of ~20,000 tonnes per year. Electricity is another option for industries looking to decarbonise their heating and cooling processes, but with increasing demand on the national grid as industry moves away from fossil fuels, geoheat offers an “off-grid” solution that is more cost-effective than electricity (Table 1) and is not subject to spot price fluctuations. Geothermal energy can deliver the lowest cost per giga-joule of any energy type.

TABLE 1 2021 Estimated cost of heat energy including carbon charges at \$65 / tonne for different fuel types.

Type	\$/GJ	Carbon Factor tCO ₂ e/GJ	Carbon Costs \$/GJ ¹	Conversion Factor ⁹	Total Cost \$/GJ Heat Delivered
Geothermal Direct	8	0.0070 ²	\$0.46	0.83 ³	\$10.19
Electricity Heat Pump	30	0.0265 ⁴	\$1.72 ⁵	2.5	\$12.00
Biomass	8	0	\$0.00	0.64	\$12.50
Coal	6	0.0944 ⁶	\$6.14	0.81	\$14.98
Gas	10	0.054 ⁷	\$3.51	0.85	\$15.89
Wood Pellets	14	0	\$0.00	0.81 ⁸	\$17.28
Electricity Resistive	30	0.0265 ⁴	\$1.72 ⁵	1	\$30.00

1 - Carbon at \$65/tonne – Jarden Securities limited <https://www.commtrade.co.nz> Downloaded 30 November 2021.

2 - Kawerau Industrial emissions factor (steam) from Climate Change (Stationary Energy and Industrial Processes) Regulations 2009 Geothermal p74 Table 6 Part A - 0.0194 times 1000/2780 to convert to t/GJ

3 - Using Geothermal steam - computed from geothermal steam (2780J/g) condensed to 100 C liquid (461J/g)

4 - MBIE data for 2019 – 157.75 PJ of electrical energy and 4,181.26 kt CO₂ equivalent emitted – Carbon factor is 0.0265 tCO₂e/GJ

5 - Carbon cost associated with electricity is included in the purchase price for electricity. User does not pay this as an additional charge under the Emissions Trading Scheme.

6 - Emissions factor for lignite from the Climate Change (Stationary Energy and Industrial Processes) Regulations 2009 (SR 2009/285) p73 Table 2

7 - Emissions factor for natural gas from the Climate Change (Stationary Energy and Industrial Processes) Regulations 2009 (SR 2009/285) p75 Table 10

8 - Wood pellet conversion efficiency set to be the same as coal

9 - Factor applicable for delivery of heat energy and not for conversion to electricity

¹ URL link to document <https://www.nggeothermal.org.nz/downloads/NZGA-CCC-Submission-FINAL-March-2021.pdf>

The value proposition of geoheat presents as an attractive opportunity for new businesses. It is applicable to a diverse range of industries that require cooling or heating, such as food and beverage manufacturing, wood processing, horticulture, aquaculture, concrete curing, bioprocessing and dairy processing. Figure 1 identifies generic uses and examples of industries that could use geoheat.

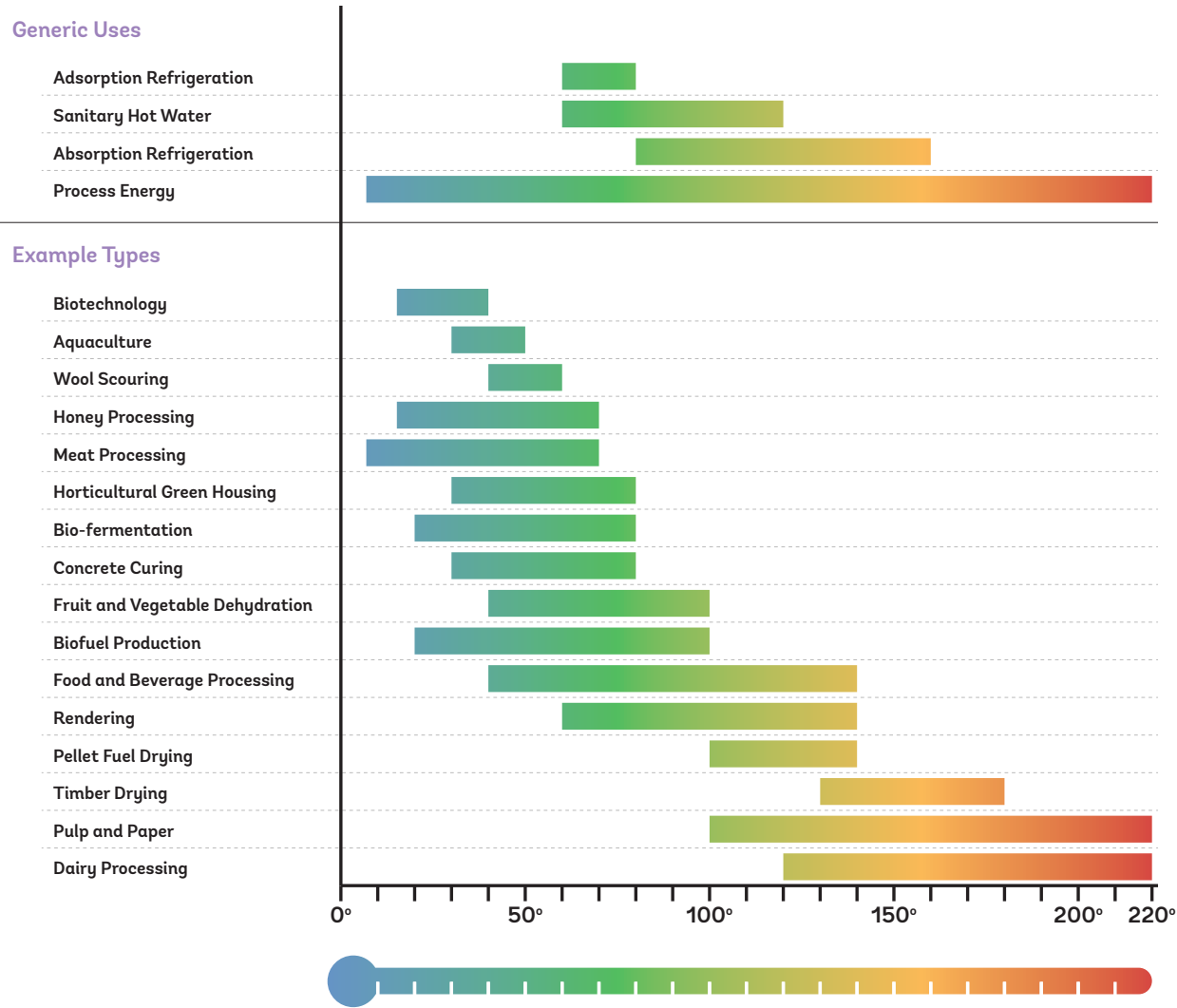


FIGURE 1 Geoheat Uses

GEOHEAT STRATEGY FOR AOTEAROA NZ, 2017-2030

He kai kei aku ringa.
There is food at the end of my hands.
A person (or people) should use their abilities and resources around them
to create success for themselves and future generations.

The Geoheat Strategy for Aotearoa New Zealand, 2017 – 2030 (Climo et al, 2017) sets two overarching goals for geothermal process heat in Aotearoa New Zealand:

- 1. Annual direct primary geothermal energy use is increased by 7.5 PJ in new projects in the period 2017-2030; and
- 2. Geothermal direct use business operations are employing (directly and indirectly) an additional 500 people associated with new projects in the period 2017-2030.

To put these in perspective, a timber drying facility might use in the order of 1 PJ / annum of direct primary geothermal energy use, where a glasshouse (approx. 12 ha) might use less than 0.3 PJ / annum. So to reach the 7.5 PJ / annum target the Strategy envisages the creation of a number of larger direct use projects (e.g. timber processing, low-emission fuel production, large glasshouses) as well as a range of smaller projects (e.g. food, beverage, smaller horticulture operations).

The shorter time period Action Plans have been developed to focus activity of the Geoheat Action Group and others involved in delivering the Geoheat Strategy.

SCOPE

The Strategy, and Action Plans to date focus on the direct use of geothermal heat and energy for industrial and commercial scale projects, with a regional focus on the established (developed) geothermal resources of the Central North Island (Figure 2). This targeting leverages the operational viability of geothermal development in these areas, in that the geothermal reservoirs and associated facilities with the ability to be utilised now are ready and waiting at these Brownfield sites. Additionally, there is strong alignment with regional development initiatives in these areas.

Brownfield is a proven resource and producing geothermal field with geothermal fluid and energy handling infrastructure in place.

Greenfield is a geothermal area with no existing geothermal development infrastructure.

The Strategy explicitly excludes geothermal electricity generation and geothermal (ground-source) heat pumps. It doesn't discount 'greenfield' developments, or lower temperature resources in other regions, such as Tauranga. These have not been a priority in previous Action Plans, however, whilst not a priority, attractive opportunities should be assessed and progressed.

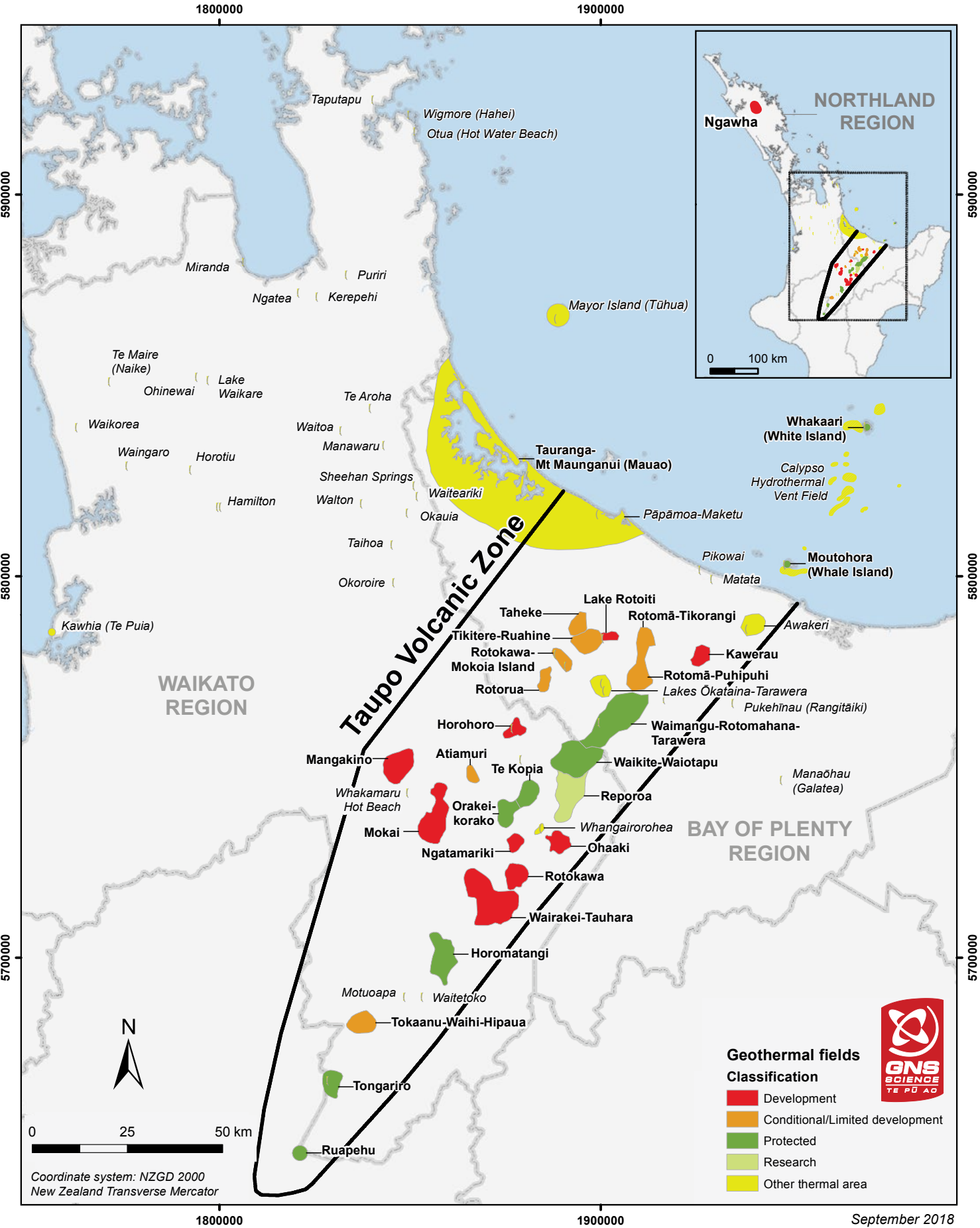


FIGURE 2 Geothermal fields of the Central North Island and Northland

IMPLEMENTATION APPROACH

The Geoheat Action Group is the primary vehicle for driving implementation of the Action Plan, with members spanning a range of stakeholder groups and interested parties (Figure 3). Together, the group aims to raise the profile of geoheat operations and opportunities beyond

the geothermal industry, including central government, industry, and funder and investor communities, leveraging collective networks, activity and resources to attract industrial and commercial energy users and businesses to geothermally rich regions.



FIGURE 3 Geoheat Action Group and organisational linkages.

A review of progress from the 2020-2021 Geoheat Action Plan is detailed on pages 18 to 21. The Strategy document, Action Plans for 2018-2019 and 2020-2021, and associated resources can be accessed via links on page 23.

2022-2023 ACTIONS TO ACCELERATE GEOTHERMAL PROCESS HEAT USE

The focus of the 2022-2023 Geoheat Action Plan is on increased use of geoheat by industrial or commercial enterprises in central North Island locations, where geothermal energy is already a well-established low-carbon energy option.

OUR APPROACH

Six actions in the 2022-2023 Geoheat Action Plan are designed to deliver two complementary objectives.

The Actions are not isolated workstreams. Rather, they are integrated and mutually-reinforcing, intended to make connections, raise awareness about geoheat opportunities, converting business interest into tangible development projects.

To accelerate the pace of activity through 2022-2023, members of the Geoheat Action Group will collectively advance the Actions, supported and supplemented by a dedicated geothermal business development role.



Paper making - Essity - Kawerau



Gerberas - PlentyFlora - Horohoro

OBJECTIVE 1: POSITION GEOHEAT

That geothermal heat is well represented in Government and industry strategies, and becomes top-of-mind as Aotearoa New Zealand’s proven, cost-effective, low-carbon energy option.

The advantages and opportunities for using geothermal heat energy need to be well recognised nationally. This will further industry (and New Zealand’s) ability to decarbonise.

It has never been more important, at a time when low-carbon, off-grid renewable energy is a rapidly growing area for investment, to better position geoheat in this landscape. It is crucial to influence stakeholder

perceptions on the geoheat value proposition to realise geoheat as an ideal future-proofed solution for a range of industries and commercial enterprises.

This positioning will seek to influence Government policy direction and complement broader industry efforts positioning geothermal as a low-carbon energy resource for a variety of applications, including energy generation, process heat and more.

OBJECTIVE 2: NEW GEOHEAT PROJECTS

At least five new projects (including energy conversions and expansions of existing operations) using Geoheat are committed to and in development, by the end of December 2023.

In a continuation of the current approach, and building on wider recognition of geothermal advantages, business development activity will focus on energy and fluid capacity available at existing geothermal

sites (Brownfield), where geothermal resources can be readily accessed and new opportunities created quickly. New businesses will bring flow-on social and economic benefits, including increased employment.

SIX ACTIONS TO BE UNDERTAKEN:

COMMUNICATE

Description: Raise the profile of geothermal process heat advantages and opportunities.

Why? The Geoheat Strategy, and the advantages of using geothermal resources, are not widely known, nor recognised as nationally significant to our energy profile. Focussed and coordinated communication, public relations and advocacy efforts will address this gap to ensure geoheat is better recognised and actively considered as a low-carbon energy option that can help New Zealand achieve its climate targets.

Approach: Develop and implement a communication strategy that maps stakeholders and audience(s) and unifies key messages. To reach across industry sectors, investors and businesses, we will leverage the resources, networks and communication channels of partnering organisations. At least 24 outputs will be delivered, using mainstream media, newsletters, social media, popular press, industry publications, and presentations at conferences and events. This activity will contribute into broader geothermal sector communications, coming from the New Zealand Geothermal Association and organisational partners.

PARTNER

Description: Partner with stakeholders across industries, sectors, government, investors and Māori entities, with a focus on regional and local economic development organisations, to unlock funding geothermal solutions for New Zealand's low carbon energy future. This will grow regional prosperity and enable job creation.

Why? Equitable access to funding is needed to incentivise and de-risk investment in geothermal projects.

Approach: Grow clusters of 'like minds' to assist with increased geoheat use. Target key individuals, seeking their active participation in Action Plan delivery. Collectively, identify relevant government organisations, funders and investors, seeking to unlock funding to support our partners in advancing feasibility studies, business cases and decarbonisation projects. Look for opportunities to inspire people to join geothermal industry businesses.

REPRESENT

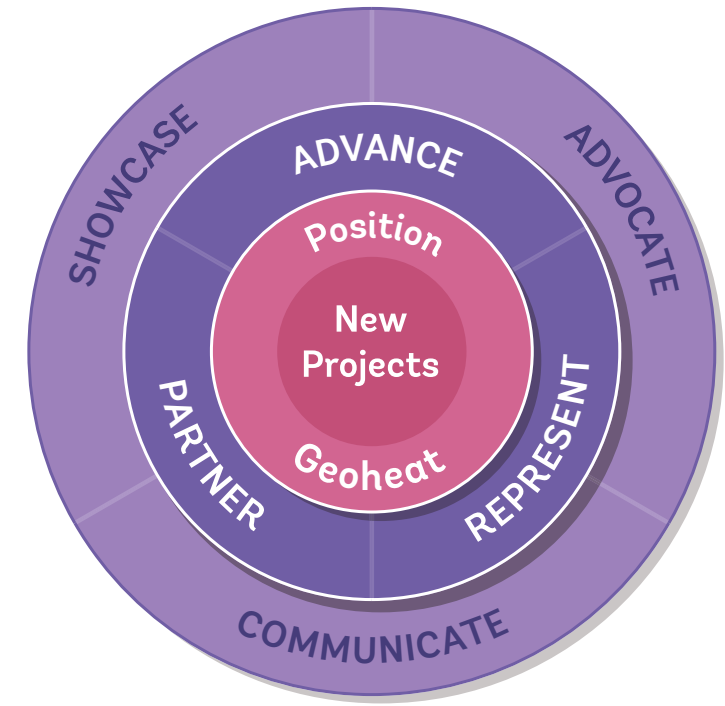
Description: Secure funding for, and appoint, an experienced business development specialist to represent the geoheat community.

Why? Increased geoheat use is a multi-stakeholder initiative. Aotearoa New Zealand can realise greater and faster impact (i.e. new projects, decarbonisation, economic development, employment) by working together at scale. An independent geothermal business development role speaking and acting on behalf of those involved in the Geoheat Strategy initiative is powerful, promoting what the industry as a whole can offer and eliminating perceived bias from individuals representing one organisation, location or opportunity.

Approach: Target participating partners, including regional economic development agencies, government, industry, NZGA, and Māori organisations, to collaboratively scope and jointly fund this role (ca. \$150,000 pa). The dedicated role will generate leads, make connections and support businesses to convert interest in geoheat opportunities into tangible projects.



GEOHEAT ACTION PLAN 2022 - 2023



OBJECTIVE 1: POSITION GEOHEAT

Geothermal heat is top-of-mind as Aotearoa NZ's, cost effective, low-carbon energy option

OBJECTIVE 2: NEW GEOHEAT PROJECTS

At least five new projects by the end of December 2023

SHOWCASE

Description: Build a repository of information that showcases geoheat success stories, to increase awareness and stimulate further investment and development.

Why? Success breeds success. Future projects can learn from and build on past developments, providing confidence through highlighting the development pathway for others to follow.

Approach: Work as a collective to profile existing and newly established businesses who are using geothermal resources, to share experiences, information and lessons learned. Direct businesses to partner with organisations providing geothermal heat, to join geothermal energy hubs, and to explore and develop incubation opportunities.

ADVOCATE

Description: Engage with think-tanks, government policy and planning processes and energy strategy development where geothermal should be championed.

Why? Geothermal is often misrepresented and/or discounted as a viable low-carbon energy option in government and sector forward planning. The Climate Change Commission report and subsequent budgets provide an opportunity to work with government, business and industry decision-makers (local, regional and national), to ensure geothermal is included as a viable option contributing to New Zealand's low carbon energy future.

Approach: A connected and cooperative industry, aligned with government directions, can effect far greater change than individual efforts. Participate in consultation processes, have a presence at (non-geothermal) industry forums, and advocate for increased use of geothermal process heat.

ADVANCE

Description: Identify, nurture and support businesses to explore and commit to new geoheat projects, focusing on Brownfield sites where geothermal resources can be readily accessed and new opportunities quickly realised.

Why? New business growth and employment opportunities in renewable energy can be achieved from geoheat use, but many process heat users don't know where to start or how to connect with geothermal suppliers, or what funds or investment might be available to support this. This activity will positively impact business uptake, emissions reductions, regional infrastructure development and Māori economic development.

Approach: Connect potential users with geothermal suppliers, by actively seeking business targets and developing relationships, and help support their efforts to secure funds or investment. We will provide specialist advice, data and information, especially for small to medium enterprises, with limited in-house expertise and funding. We will support at least 15 business cases (for new business opportunities, and energy conversions from existing businesses), to assist projects to move from concept through to investment and commissioning.

GEOTHERMAL PROCESS HEAT SHOWCASE

In this Action Plan, we share examples of geothermal process heat use in Aotearoa New Zealand by showcasing two wood processing operations. These are large companies in the Kawerau geothermal industrial park who rely on geothermal resources to supply a significant part of their high-temperature process heat requirements.

The first example details Oji Fibre Solutions' 2019 energy transition, converting from a fossil fired boiler to process steam produced from geothermal steam. The second celebrates 64 years of geothermal process heat supply to Kawerau's Tasman Mill. We take this opportunity to celebrate the global legacy of innovation by Norske Skog Tasman in developing the technology to produce process grade (clean) steam from geothermal steam.

A BOILER CONVERSION FOR OJI FIBRE SOLUTIONS - KAWERAU

Oji Fibre Solutions process around 1.25 million cubic metres of wood a year, converting it into unbleached kraft pulp (for the manufacture of paper and tissue) and fibre cement pulp (used for the production of building products).

In 2019, Oji embarked on a transformation project to their Kawerau mill, including the elimination of coal through increasing the use of geoheat. Previously, to provide steam for process heat requirements, Oji burnt coal, waste oil and wood residues (biomass) in a boiler. Investing in a steam line from Ngāti Tuwharetoa Geothermal Assets (NTGA) secured a continuous supply of process quality steam to the mill, produced from geothermal steam. The boiler was decommissioned, with the conversion eliminating the use of coal. This also reduced the use of oil creating an opportunity for wood waste to be used in other ways. The conversion directly reduced CO₂ emissions from the Oji Mill by 10,000 tonnes

per annum, resulted in operational savings of \$4M per annum and indirectly avoided a further 10,000 tonnes per annum of CO₂ emissions through wood residues no longer required at Kawerau being transported and used as biofuel at the Oji Kinleith Mill near Tokoroa.

A two page [case study](#) prepared by Oji in 2019, part way through project implementation, provides additional detail (Oji Fibre Solutions 2019) and a [YouTube video](#) on the boiler replacement project is also available.

In 2020 - 20% of the mill's annual energy requirements of 7.77 PJ was met from geothermal energy (1.64 PJ) (Oji Fibre Solutions, 2021).

The project was a finalist in the EECA 2021 Large Energy User Initiative of the Year Award for outstanding energy-related initiatives that have delivered significant benefits. This Award category was open to all New Zealand's large energy users.



NTGA geothermal / process steam generation facility supplying process steam to Oji.

PAPERMAKING AT THE NORSKE SKOG TASMAN MILL



"Our legacy is that people copied us. The benefit has been immeasurable."

Joe Hotson (2018)
Norske Skog Tasman

This case study acknowledges the staff at the Tasman Pulp and Paper Company who in the 1980's developed the innovative Geothermal Process Steam Reboiler technology which delivers process grade (clean) steam.

Operating since October 1955, the newsprint production operation from the Tasman mill closed in 2021 after operating for 66 years (Yeoman, 2021) as a consequence of the rapidly reducing demand for printed news in the era of electronic media.

The mill was part of visionary forest and timber industry planning for New Zealand that commenced in the early 1920s, with the New Zealand Forest Service planting forests on the Kaingaroa Plateau for softwood timber production (NZ Archives, 1957). Utilisation of geothermal energy became a part of the plan, with geothermal wells drilled in the early 1950s and with geothermal energy supplied to the mill from 1957.

Geothermal steam was not able to be used directly in the paper machine driers because of the non-condensable gases present in that steam (Hotson, 1994), so the geothermal steam was used to raise process steam in heat exchanges (vaporisers). However, the poor quality of the feedwater used to produce the process steam meant that the shell side of the vaporisers fouled quite rapidly and had to be cleaned every six months.

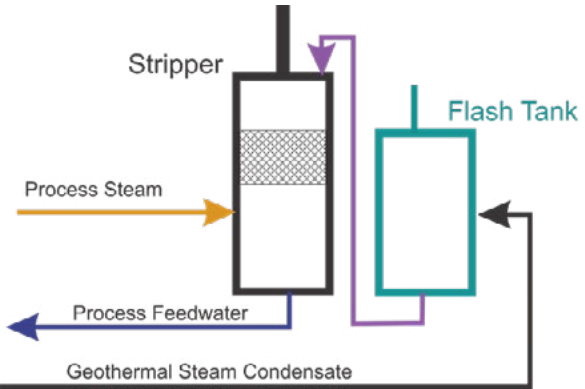


Figure 4 Schematic of the plant to de-gas the Geothermal Condensate to produce boiler quality feedwater.



Photo of the plant at the Tasman Mill to de-gas the geothermal condensate producing feedwater. Two parallel process streams; two stripper vessels on the left and two flash tanks on the right

In the 1980s a group of staff, led by Joe Hotson, solved the vaporiser scaling and cleaning issue by focussing on improving the feedwater quality. They developed an innovative method to de-gas the oxygen-free geothermal condensate, whilst keeping the ammonia in the water to produce boiler quality feedwater (Refer to Figure 4 for a process schematic).

The ensuing high quality feedwater was supplied to the process steam-raising side of the geothermal / process steam heat exchangers, completing the Geothermal Process Steam Reboiler innovation. This was engineered to full plant operation by 1988 (refer the photo above). This world-leading geothermal technology was utilised by Norske Skog Tasman for 22 years before being adopted by others. Ngāti Tuwharetoa Geothermal Assets further developed the reboiler process to operate at higher pressures in 2010 and are presently supplying process steam to Essity, Waiū and Oji at Kawerau. Tuaropaki also adopted the technology in 2011 to supply process steam to the Miraka Dairy Factory at Mokai.

EFFECTIVENESS REVIEW OF 2020 – 2021 GEOHEAT ACTION PLAN

This section looks back, to review and record the progress of the 2020-2021 Geoheat Action Plan, which proposed eleven actions, designed to deliver two objectives. A brief status report, with evidence where appropriate, is detailed below. While achievement against targets was mixed, the net activities driven by the 2020-2021 Action Plan, and delivered by the Action Group members advanced the growth of geoheat use by industrial and commercial enterprises.

OBJECTIVE 1	STATUS PARTIAL	<p>New direct geothermal projects, generating at least 80 FTE jobs, are committed to and in development by end of December 2021.</p> <p>The Covid-19 lockdowns and quarantines in New Zealand made this a difficult period for businesses to establish, and existing businesses had to navigate different business dynamics. Of particular note, in June 2021, the Norske Skog Tasman newsprint papermaking operation at Kawerau closed. After 66 years of operation the demand for newsprint had declined to the point that this operation was no longer viable. With the closure of the facilities, one hundred and sixty jobs were declared redundant and 2.4 PJ per annum of geothermal energy ceased to be required by the mill.</p> <p>However, during the same period, new geothermal process heat and direct use geothermal projects (including energy conversions) have been committed to and are in various stages of development. We expect them to commence operations in 2022 and beyond. Over 30 business cases were prepared for potential geoheat operations (see Action 4 page 19), and some of these are progressing to funding applications, full feasibility, due diligence and raising finance (specific information on the majority is commercial in confidence prior to a public announcement by the business).</p> <p>Tissue manufacturer Essity (previously Asaleo) was awarded \$1.65M from the EECA GIDI fund to switch more of their drying operations at their Kawerau-based operation from natural gas to geoheat as part of a \$15M upgrade.</p> <p>The five new businesses beginning to use geothermal process heat in the 2018-2019 period, with approximately 150 new FTE's projected to be involved, are on track to deliver this outcome.</p> <p>Beyond process heat, interest in geothermal as a sustainable resource continues to grow. The Tuaropaki / Obyashi joint venture Halcyon Power commissioned a 1.5MW geothermally-powered hydrogen pilot plant in June 2021. Geo40 commissioned their Northern Plant at Ohaaki (for silica extraction) in 2020. In early 2021, Contact Energy commenced building their 168MW Tauhara geothermal power station near Taupō, which includes land set aside for large-scale industrial geoheat users.</p>
OBJECTIVE 2	STATUS PARTIAL	<p>Secure funding to drive Strategy implementation for the next two years (ca. NZD 300,000).</p> <p>A geothermal Business Development Lead (BDL) was contracted for six months (January-June 2020) as part of 2020-2021 Action Plan activity. The role had been operative since December 2017, funded by the Bay of Connections (BoC), MBIE, NZGA, Ngāti Tuwharetoa Geothermal Assets, Contact Energy Limited, Mercury Limited and Tauhara North No.2 Trust. Funding was not forthcoming beyond June 2020 for strategy co-ordination, leaving a significant gap in activity associated with this role through to the end of 2021. Amplify (the Taupō Economic Development Agency) funded a part-time Geothermal Cluster Lead through the 2021 calendar year. Having a geothermal business development role has been recognised by stakeholders as vitally important and resourcing this going forward will be a continued priority.</p>

ACTION 1	DESCRIPTION	STATUS PARTIAL
Funding Strategy	Develop and implement a funding strategy to secure funding for 2020 -2021 and beyond.	Activity to advance the Geoheat Strategy and Action Plans was mostly self-funded by passionate and interested individuals, with their time supported by their employing organisations. The geothermal Business Development Lead was funded for the first six months of the 2020-2021 Action Plan period. In late 2021 Amplify committed to fund the Geothermal Cluster Lead.
ACTION 2	DESCRIPTION	STATUS PARTIAL
Partner with Māori Organisations	Establish / develop productive working partnerships with willing Māori organisations to assist in the achievement of aspirations for geothermal energy use and development.	<p>There have been informal discussions and interaction with Toi Kai Rawa leading to interest in geothermal energy, including direct geoheat use, evidenced in their programmes for younger Māori to train in science, technology, engineering, arts and maths (STEAM) occupations. Future opportunities in geothermal enterprises were identified as one sector that will assist in shifting the labour force up the value chain.</p> <p>Rangatahi visited the NTGA Kawerau geothermal facilities as part of a STEAM Discovery Tour, providing a positive industrial experience and showcasing Māori enterprise in the geothermal sector (Link to video of the event).</p> <p>Contact Energy launched the Ka Hiko o te Iwi program, looking to upskill local workers to be job-ready for geothermal construction jobs.</p>
ACTION 3	DESCRIPTION	STATUS PARTIAL
Partner with Central Government	Partner with central government agencies to find geothermal solutions to support greenhouse gas emission targets and job creation strategies.	No formal partnerships have been formed, and changes to staffing in central government have made relationship building a challenge. In early June 2021, a group from the Geoheat Action group arranged and attended meetings with the Private Secretary to the Minister of Energy and Resources, MBIE, MPI Forestry Investment and EECA. MPI Forestry expressed real interest in Geothermal Process Heat as an input into the NZ forestry / wood model, from forest to product, they are developing. The Energy Efficiency and Conservation Authority (EECA) have participated in Action Group meetings. The Geoheat Action Group submitted to MBIE's Process Heat in New Zealand initiative and the discussion document Accelerating Renewable Energy and Energy Efficiency (MBIE, 2019) (Daysh and Carey, 2020).
ACTION 4	DESCRIPTION	STATUS ACHIEVED
Deliver Business Cases	Produce at least 10 funded business cases for geothermal conversion for targeted existing business and for new business opportunities	More than 20 business cases were developed, ranging from early phase assessment through to comprehensive feasibility cases. This work was undertaken by heat users (and consultants), in partnership with Contact Energy Ltd, Ngāti Tuwharetoa Geothermal Assets, or Amplify (previously Enterprise Great Lake Taupō). Some, but not all, of these projects are progressing to feasibility studies, due diligence and raising of finance. The specifics of this information is commercial in confidence.

ACTION 5	DESCRIPTION	STATUSACHIEVED
Strategy Consultation	Through various opportunities provided for industry interaction (e.g. New Zealand Geothermal Workshop), this Action Plan and the Strategy will be discussed for feedback.	Given the high level of engagement in Strategy implementation and the successes achieved to date, the approach is to seek continued engagement, interest, input and involvement, rather than a full Strategy review. Strategy and Action Plan consultation was undertaken as part of The NZ Geothermal Workshop in November 2020, and through the NZ Geothermal Association networks in the first few months of 2021. Additional consultation has been undertaken as part of preparation of the 2022-2023 Action Plan.
ACTION 6	DESCRIPTION	STATUSACHIEVED
Action Group	Continue to maintain and grow clusters of 'like minds' to assist with growth of geothermal energy use. Strive for connected and cooperative industry to affect far greater change than individual efforts.	Twelve Action Group meetings held through 2020-2021. The development of a communications strategy for the 2022-2023 period commenced in November 2021 with a survey followed by meetings on the 30th November and 2nd December. The Action Group's email list has grown to over 30 members.
ACTION 7	DESCRIPTION	STATUSACHIEVED
Network & Connect	Maintain and grow connections and networks to raise the geothermal profile. Establish services and mechanisms to provide interaction between potential geothermal heat users and heat suppliers. Develop broader targeted engagement with identified Māori organisations.	<p>Amplify, NZGA and the geothermal sector delivered a week of 16 quality events in Taupō during the inaugural NZ Geothermal Week (26th – 31st July 2021). This included a geothermal process heat showcase, field trip and a geothermal residential subdivision heating workshop (event URL).</p> <p>Amplify also hosted an algae workshop for generators and commercial algal experts in May 2021, sharing and discussing algal-based opportunities, which will require low-grade heat, to create value from the industry's CO₂ emissions.</p>
ACTION 8	DESCRIPTION	STATUSACHIEVED
Process Heat in NZ	Actively participate in the MBIE / EECA Process Heat in New Zealand initiative through 2020 - 2021.	The Geoheat Action Group has actively participated, submitting (Daysh and Carey, 2020.) to the MBIE discussion document Accelerating Renewable Energy and Energy Efficiency (MBIE, 2019). The MBIE document brought together two work streams: accelerating renewable electricity and lowering emissions from process heat. In 2021, there have been informal discussions with EECA on the Government Investment in Decarbonising Industry (GIDI) funding, and with the Energy Transition Group in MBIE's Energy & Resource Markets team.

ACTION 9	DESCRIPTION	STATUSACHIEVED
Showcase	Actively showcase existing success stories in geothermal energy use to increase awareness and stimulate further development. Share information. By sharing lessons learned, future projects can learn from and build on past successes. Success breeds success. Collect data that enables effective monitoring of the strategy goals.	<p>Geoheat Action group participants prepared a paper for the NZGW 2020 (Climo et al, 2020) and three papers for the proceedings of the World Geothermal Congress 2020+1 Reykjavík Iceland (Hawker-Green et al, 2021; Climo et al, 2021; McClintock, 2021)</p> <p>The NZ Geothermal Week, Process Heat Showcase (27 July 2021) highlighted the opportunity for geothermal process heat to an audience of industry, start-ups, government agencies and investors. A field trip to local process heat sites included Contact Energy's large-scale industrial site (part of the new Tauhara power station development), Contact Energy's Rakaunui Road block, suited to SME process heat users, and Huka Prawn Park, where a new heat exchanger and tourist-friendly location offer additional geoheat opportunities.</p>
ACTION 10	DESCRIPTION	STATUSACHIEVED
Education and Training / Skills	Look for opportunities to create skills / learning programs for new professionals entering the geothermal industry. Look for opportunities to create cadetships within existing companies / organisations. Develop, as appropriate, specific courses (including developing scholarship opportunities for those courses) in partnership with university or other training organisations.	<p>Several events were run during NZ Geothermal Week (26-31 July 2021):</p> <ul style="list-style-type: none">• Amplify coordinated 25 geothermal industry STEM Ambassadors who ran in-school Science, Technology, Engineering, and Math (STEM) activities, reaching over 720 students in 18 schools throughout the Taupō district.• GNS Science and MB Century sponsored school Science Competitions, attracting entries from over 58 teams (over 250 students).• Amplify ran a Career Expo highlighting current jobs and career pathways in the wider geothermal sector, with over 20 industry and educators exhibiting. Over 800 students and members of the general public attended. <p>Rangatahi under the umbrella of Toi Kai Rawa visited NTGA Kawerau geothermal facilities.</p> <p>Women in Geothermal (WING) launched their two-week internship program for female Year 11 & 12 students in the Rotorua and Taupō areas.</p> <p>Contact Energy continues to be involved with the Tertiary Education Commission Gateway Program, which provides school students with structured workplace learning across a range of industries and businesses.</p>
ACTION 11	DESCRIPTION	STATUSPARTIAL
Partner with Central Government	Develop 'how-to' reference guides. At the smaller scale, the complexity of developing a geothermal use can be a barrier. Plain language advice and information on regulatory requirements, technology and resource information could assist to reduce barriers and enhance connections.	<p>The three documents in the Go-Geothermal series</p> <ul style="list-style-type: none">• Go-Geothermal – Industrial• Go-Geothermal – Commercial• Go-Geothermal – Residential <p>have been drafted and are being finalised for publication.</p>

GLOSSARY

BDL	Business Development Lead
BoC	Bay of Connections. www.bayofconnections.com
Brownfield (Development)	A proven resource and producing geothermal field with existing geothermal development infrastructure
CCC	Climate Change Commission
Direct Use / Direct Geothermal Use	The use of geothermal energy or fluid directly. Essentially, this is any application using geothermal heat for a purpose other than generating electricity.
EECA	Energy Efficiency and Conservation Authority
Geothermal energy / Geoheat	Thermal energy sourced from underground
GJ	Giga Joule, a unit of energy equal to 10 ⁹ Joules.
Greenfield (Development)	A geothermal area with no existing geothermal development infrastructure
NTGA	Ngāti Tuwharetoa Geothermal Assets
NZGA	New Zealand Geothermal Association
PJ	Peta Joule, a unit of energy equal to 10 ¹⁵ Joules.
Primary Geothermal Energy	The total amount of geothermal energy supplied to a process. This will usually be greater than the amount of energy consumed in the process.
Renewable Energy	Energy produced from solar, wind, hydro, geothermal, biomass, tidal, wave, and ocean current sources. Definition from the Interpretation section of the RMA (1991).
Toi Kai Rawa	Māori development agency promoting Māori economic development within the wider Bay of Plenty. (http://www.toikairawa.co.nz/)

REFERENCES & LINKS

GEOHEAT STRATEGY DOCUMENTS AND LINKS

Resource	Hyperlink
Geoheat Strategy for Aotearoa NZ, 2017 – 2030	Click here
Geoheat Action Plan, 2020 - 2021	Click here
Geoheat Action Plan, 2018 - 2019	Click here
Geoheat Strategy Launch Video, 2017	Click here

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