Wider benefits from ambient and low temperature Geoheat. Why don't we get it?

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ABSTRACT

Decarbonising NZ's energy system is complex and costly, using local energy resources reduces the need for capacity in the interconnected energy delivery systems, with low temperature Geoheat providing an opportunity waiting to be harvested, being present across virtually all of the nation.

The broader Tauranga area has an expansive low temperature geothermal system that is currently used for heating pools, space and water heating, and irrigation, but has potential for so much more. The Mount Industrial area contains a number of large heat users, of which a number currently burn gas. The area has electrical network capacity constraints. Heat pumping can provide medium temperature process energy replacing gas in some applications.

New Zealand's horticultural sector is transitioning from gas and coal. Work is underway to raise the awareness of using ambient and low temperature geothermal as a base energy source.

Commercial and residential heating and cooling networks can share subsurface infrastructure and resources, allowing more efficient energy use, lowering carbon footprints, and contributing to healthier work and living environments.

Ambient and low temperature local geothermal resources can contribute now to reducing system capacity growth required as part of NZ's decarbonisation. The challenge is to "get it" and to understand what using these geothermal energy resources across the nation means for individual users, energy networks, the network capital required and for our nation overall.

1. INTRODUCTION

This paper provides information on a number of work streams underway in ambient and low temperature geothermal. Geothermal energy is widely available across New Zealand in the ground water and in a number of locations in accessible geothermal water[1]. This thermal energy is available for use in various processes with different technologies used to supply the energy to meet the temperature requirements of a given process application.

[1] Geothermal water is defined in the RMA 1991 as water in the ground at 30 ºC or above.

Increasingly since 2021 / 2022 with the cost of carbon increasing (Figure 1) and the introduction under the RMA in July 2023 of a National Policy Statement (MfE 2023) and a National Environmental Standard (RMR 2023) for greenhouse gas emissions from industrial process heat there has been growing interest in ambient and low temperature geothermal resources. The horticultural sector is investigating using geothermal heat pumps and low temperature Geoheat to support growing conditions in covered crop facilities replacing coal or natural gas to provide the heat for greenhouse temperature conditioning.

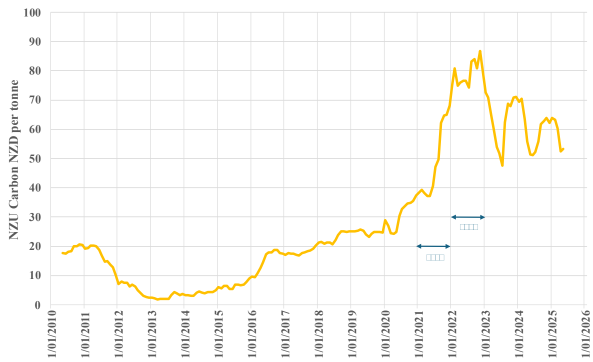

Figure 1: Cost of carbon – NZU NZ dollars per tonne. Data from Github.

There are about 250 hectares of green houses in NZ, which require about 1.5 MW_{th} of heat per hectare during the winter peak making a total NZ greenhouse peak heating capacity of some 370 MW_{th}. Total annual energy use is estimated at ~700 GWh_{th} on the basis of a 20% capacity factor.

The Whakatane Growers facility analysed as part of the Energy Efficiency and Conservation Authority (EECA) Bay of Plenty Regional Energy Transition Accelerator (BOP RETA) (Carey et al, 2024) is discussed in more detail (Section 3.1), as is the Whakatane Hospital (Section 3.2). Assessments have been made on the basis of using geothermal energy in 15ºC groundwater retrofitted into the operations to replace the current fossil energy heating systems.

Material presented in the paper considers the benefits gained if the water temperature available at a given site is slightly warmer then 15ºC groundwater, as for instance occurs in parts of the Tauranga Geothermal System (TGS). Work investigating the potential of using the warm water available in the TGS undertaken in 2024 – 2025 is briefly canvassed.

The Ministry of Primary Industries (MPI) Sustainable Food and Fibre Futures Fund (SFFF) is supporting investigations assessing Geoheat opportunities for covered crops in the Auckland, Waikato and Bay of Plenty Regions of the North Island. The project is a collaborative effort between GNS Science, Vegetables NZ, Tomatoes NZ and GeoExchange NZ, making geological data, hydrological data, and energy and economic assessments accessible to growers in support of business cases to convert to Geoheat technologies. More details are provided in Section 5, and in Seward et al (2025).

There is brief discussion on the GNS Science overall Energy System modelling work that has been undertaken for NZ.

The New Zealand Geothermal Association (NZGA) in collaboration with the EECA in 2025 has produced a Business Guide (NZGA / EECA 2025) with a focus on low- and medium-temperature geothermal energy, Geoheat utilisation and applications.

The benefits from Geoheat, across a broad temperature range are discussed in the concluding remarks in this paper.

2. CARBON COST SAVINGS FROM USING GEOHEAT

If geothermal process heat energy can be used instead of fossil energy for a given application, then significant operational cost savings can be achieved. One operational saving is related to carbon payments under the Emission Trading Scheme (ETS). The 2024 – 25 Geoheat Action Plan (Carey et al 2024a) tabulated emissions reduction data (p12) for geothermal steam, two phase fluid and water relative to natural gas and coal based on data in Schedule 2, Tables 2, 6 and 10, in the Climate Change Regulations - Stationary Energy and Industrial Processes 2009 (CCR 2023). The emission reductions translate directly into reduced payments under the ETS at any given time. Table 1 summarises the percentage savings achieved through using Geoheat relative to fossil energy.

Table 1 Percentage ETS carbon cost saving potential through using Geoheat relative to Natural Gas or Coal.

Geothermal Fluid Type	Fossil Fuel	
	Gas	Coal
Steam	81%	88%
Two Phase	99%	99%
Water	100%	100%

3. BAY OF PLENTY REGIONAL ENERGY TRANSITION ACCELERATOR

GNS Science contributed the geothermal component to the EECA BOP RETA (Carey et al 2024b). The RETA programme aims to develop and share a well-informed and coordinated approach for regional decarbonisation. It focusses on local opportunities and barriers faced by entities when seeking to reduce process heat emissions (EECA 2025). The Bay of Plenty report included assessments on utilising geothermal resources from ambient, low temperature groundwater through to high temperature geothermal.

Below is summary material from the Whakatane Growers and Whakatane Hospital site analyses undertaken by GeoExchange for transitioning the facilities from fossil energy to Geoheat (Carey et al 2024b).

3.1 Whakatane Growers

This is a horticultural greenhouse facility with 3.2 hectares of covered area (Figure 2). The current energy delivery system uses a combination of coal and gas. The assessed maximum wintertime heating capacity to be supplied through Geothermal Heat Pumps using 15°C groundwater drawn from wells ~350m deep is 4.8 MW_{th}. The annual energy delivery to the facility is assessed at some 9300 MWh. A preliminary capital cost estimate of NZD $6.6 million was assessed for the conversion from the current fossil fired system to an all geothermal solution. A Simple payback of 2.4 years relative to an air source heat pump option is achieved. Annual CO_2e emissions reduction of 3700 tonnes (93%) are estimated relative to the current fossil fired system through adopting geothermal heating. The balance of the emissions is from the grid electricity used to run the systems.

Figure 2: Aerial view of the 3.2 hectare Whakatane Growers facility.

3.2 Whakatane Hospital

The Whakatane Hospital is a 96-bed facility comprising both older and newer building stock. The current energy delivery system uses a combination of multiple gas boilers and split style air source heat pumps. The assessed capacity required for hot water is 200 kW, for heating a maximum of 1900 kW and for cooling a maximum of 1200 kW. Annual energy for heating is assessed at 3700 MWh and for cooling at 2300 MWh. Scenarios replacing the existing system with air source heat pumps and geothermal heat pumps were developed with the geothermal system using 15°C groundwater drawn from wells ~100m deep. The geothermal system uses three abstraction and four injection wells. An indicative capital requirement of NZD $5.6 million was assessed for the geothermal system which achieves a simple payback of 2.6 years relative to an all air source heat pump option. Annual CO_2e emissions reduction of 750 tonnes (89%) are achieved relative to the current system. The balance of the emissions is from the grid electricity used to run the systems.

3.3 Benefit of Warmer Water Temperatures

Even more can be achieved if the temperature of the aquifer water is naturally "elevated". The Whakatane Growers case study was modelled with water temperatures up to 30°C, which reflects temperatures found in places such as, but not limited to; some shallow aquifers in the broader Tauranga area, in a number of areas of the Hauraki Plains, and at Parakai near Helensville, north of Auckland.

Table 2 Percentage energy savings with increasing source water temperature.

GSHP Source Temperature	System COP	Energy Savings Relative to 15°C
15°C as at Whakatāne Growers	2.8	-
20°C	3.2	15%
25°C	3.6	29%
30°C	4.0	44%

A 15°C increase in aquifer water temperature results in a 40% reduction in capital for an installation, as less equipment is required, and a 44% reduction in the annual energy costs modelled for a 4.8 MW_{th} capacity Geoheat system supplying heat at 65°C.

3.4 Geothermal System Benefits

Using geothermal heat solutions decreases the required electrical connection capacity to a given site relative to either electric boilers or air source heat pump solutions.

Both the peak electrical demand and the electrical energy annually required to run a geothermal solution are lower than an all-electric or an air source heat pump solution.

The use of local geothermal energy means that the facility is also more "shielded" from electrical energy price volatility. This benefits the facility's operations, and if more users adopt the use of local heat sources, like geothermal, it has positive implications for local and national grid investment and management.

3.5 Marginal Abatement Cost Analysis

The EECA BOP RETA full report (EECA 2024a) notes in Section 7.1.1 that "Six fuel switching projects are economic prior to 2050, delivering 10,385t of emissions reductions – 4% of the total BOP RETA process heat emissions. One involves switching to biomass fuel, while five involve switching to geothermal (either direct use or using a ground-source heat pump).

The EECA BOP RETA summary report (EECA 2024b) EECA identified on p38 "Pending more feasibility studies, it is anticipated that geothermal has the potential to play a big role. Businesses are encouraged to explore their own geothermal options."

The summary report (EECA 2024b) graphically identifies the timing of the geothermal projects, with Figure 18 replicated here as Figure 3. Page 39 of the report (EECA 2024b) identifies that using the marginal abatement cost (MAC) methodology geothermal was the optimum fuel for all the sites studied as part of the Bay of Plenty Regional Energy Transition Accelerator.

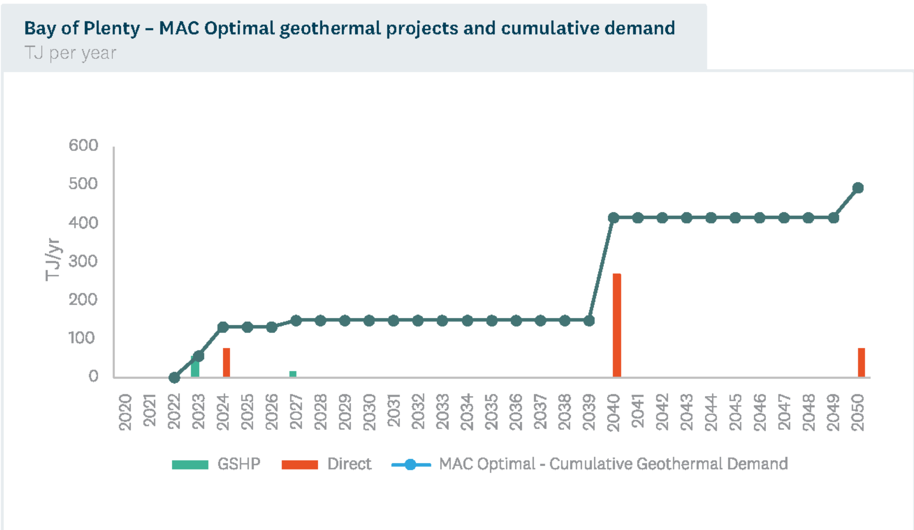

Figure 3: EECA summary report (EECA 2024b) Figure 18 replicated. MAC Optimal pathway for geothermal – technology used and cumulative demand (TJ/year).

4. LOW TEMPERATURE TAURANGA GEOTHERMAL SYSTEM

Due to evidence from the RETA that Geoheat in the Tauranga area has the potential to replace some gas heating applications, to reduce electrical demand and reduce carbon emissions, the Bay of Plenty Regional Council (BOPRC) commissioned an investigation into the Geoheat potential of the TGS. The findings of the investigation were intended to inform broader stakeholder consultation, focusing on energy resilience and regional development planning. The final report, The Geoheat Potential of the Tauranga Geothermal System (GeoExchange NZ 2024) was completed in July 2024, a BOPRC Summary (BOPRC 2024) was released in

November 2024 along with a low temperature Geoheat presentation (Wells and Carden 2024).

The Western Bay of Plenty (WBOP) is one of New Zealand's fastest growing regions with population projected to increase from 160,000 to 290,000 people by 2054. While such rapid growth has the usual stressors, energy infrastructure is a critical issue that is compounded by the need to decarbonise industry for the clean energy transition on top of the demands of population growth.

Underlying the region is the TGS. Spanning approximately 875 km² from Waihi Beach in the north to Te Puke-Maketu in the southeast, the TGS (Figure 4) is a low-temperature, single aquifer system with temperatures ranging from ~15°C to ~77°C, with 70% of consented wells less than 200m deep.

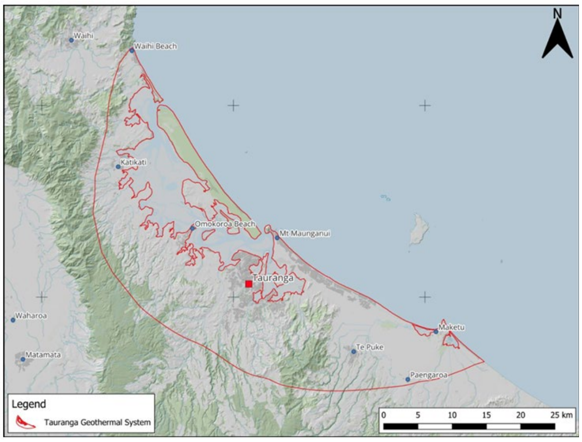

Figure 4. Nominal Boundary of the Tauranga Geothermal System –outlined in red

Although too low a temperature for electricity generation there is much potential for Geoheat applications which is currently under utilised. Current applications (Figure 5) include bathing, space heating and irrigation / frost protection – where the heat has no additional value.

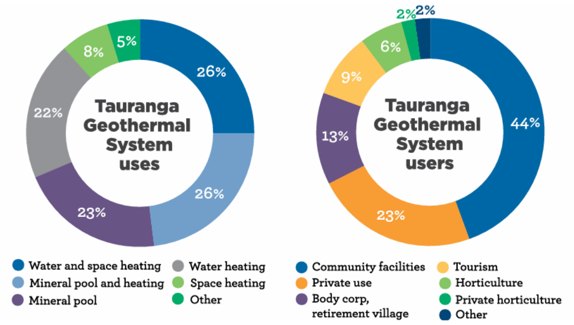

Figure 5: Percentage breakdown of existing uses and users of the Tauranga Geothermal System

The investigation's methodology adopted a holistic approach, combining technical assessments of groundwater and low temperature geothermal resources with stakeholder consultation on current practices, regional economic trends, management implications, and alignment with regional growth strategies.

One major finding was that the under utilisation of Geoheat is largely due to a lack of awareness about the resource's presence and potential. By overlaying regional growth plans and industrial locations with resource maps, the report demonstrated where Geoheat utilisation has potential, opening the door for effective outreach and investment. This approach highlights that access to clean and affordable heat is an attractive value proposition for economic development in the area / region.

4.1 Report's Impact

4.1.1 Regional Planning

Priority One, the WBOP subregion's economic development agency, began an energy strategy for the area in early 2024. Notes from the stakeholder workshops that occurred prior to publishing the strategy report do not mention geothermal heat. It is notable that geothermal heat becomes core to the identified opportunities for the region in the discussion notes after the release of the report.

The final report (Allan and Bond, 2025) includes a section on Geoheat opportunities in the WBOP and key strategic goals such as "Developing and deploying innovative technologies (hydrogen, solar, wind, geothermal) and energy storage systems, alongside incentivising trials and clean energy projects, will be crucial", now includes geothermal.

4.1.2 Resource Management

Beyond identifying Geoheat opportunities, the scope included advice on sustainable practices, technology options suited to TGS conditions and upskilling and training of the existing workforce. The report is being used by the BOPRC to inform updates to their TGS Management Plan, ensuring that an anticipated increase in the uptake of Geoheat to replace fossil heating is conducted sustainably and justly.

4.1.3 District Schemes

The report identified existing industrial neighbourhoods and greenfield development sites that are located above Geoheat resources, presenting an opportunity for broader area / district wide energy solutions. District heating and cooling energy schemes are not commonplace in New Zealand and so there is a socio-economic barrier to breakdown in order for these to eventuate. Regardless, positive conversations involving local authorities, local energy users, potential developers and central government are forming. This coalition of parties is a positive development as a key finding in GeoExchange NZ (2024) was that "the majority of international examples of district energy schemes involve the public sector to some degree, whether it is with planning strategies, incentivising development, or in many cases, the public sector has partial or full ownership of the project".

Potential district scheme locations identified in the report include: the Mount Maunganui Industrial Area, Tauranga CBD, Tauriko, Rangiuru Business Park, and Papamoa East.

Recurring themes across the various reports include grid implications of electrification, difficulties with electrifying process heat, lack of awareness of the low temperature groundwater and geothermal resource that is the TGS and the benefits of broader system solutions.

An example of a Geoheat solution that integrates these themes originated from the results of investigating an application at Dominion Salt in the EECA BOP RETA

(Carey et al 2024) and then discussions around the systemic benefits of district schemes in GeoExchange NZ (2024). Analysis from the BOP RETA indicated that using water from the TGS with a high temperature heat pump generating steam would result in a 64% reduction in annual energy input compared to an electric boiler solution. An additional investment of up to $4.5M would save $28M over a 20 year life with a payback of 4.1 years.

In the event that this system becomes part of a broader district system across the Mount Maunganui Industrial Area, the subsequent economies of scale would spread the capital investment across a number of users, encourage private sector investment and system management and provide system efficiencies with operational diversity and load sharing.

5. MINISTRY PRIMARY INDUSTRIES - SUSTAINABLE FOOD AND FIBRE FUTURES GEOHEAT FOR GREENHOUSES

MPI SFFF funds are supporting the development of a web-based tool designed to inform covered crop growers of the potential of geothermal energy in their regions and the benefits of using naturally occurring geothermal heat either directly or indirectly (Seward et al, 2025). This project has been co-designed by GNS Science, Vegetables NZ, Tomatoes NZ and GeoExchange NZ.

Internationally, tapping into subsurface geothermal resources have been proven to provide benefits for covered crop growers (e.g. MFAT, 2022). The uptake of geothermal heat use in New Zealand could be beneficial to the industry, however current information about subsurface energy resources, technology and costs are hard to find. This project aims to combine data, information and economics together to provide growers with a tool to make an initial assessment as to the potential of converting to geothermal heat at their current site or possibly at a new site.

The project includes an assessment of publicly available geological and hydrological data, cost estimates of converting a typical New Zealand greenhouse operation to geothermal heating in different climate and geological settings and estimates of energy use. The tool will provide a key input for assessing low-temperature geothermal options for individual growers' energy decarbonisation plans assisting in de-risking the geothermal option.

A series of in-person stakeholder events have been held to build support and raise awareness of the greenhouse Geoheat opportunity, with additional meetings planned as the tool develops. The objective is to make this tool as useful and accessible to growers as possible.

6. NEW ZEALAND ENERGY SYSTEMS MODELLING

A recent study by Kirkby et al (2025) provides estimates of the heat flows over New Zealand. across the Taupo Volcanic Zone (TVZ) the total heat flow is more than 3,700 MW (or 117 PJ per annum). This is more than the total process heat derived from fossil fuels used in NZ in 2016 (MBIE, 2018) – assessed to be 111 PJ per year. However, this heat flow is unlikely to be sufficient for process requirements at an individual site location.

For example, across the Whakatane Grower's site introduced earlier, the natural heat flow is about 3 kW, compared to the required heat of 3.2 MW from the subsurface aquifer to support the energy requirements of the greenhouse. On the other hand, the energy stored in the aquifer under the site is approximately 360 TJ which itself would be depleted in 3.6 years without recharge.

This analysis highlights that a Geoheat development at a given site will require recharge from the surrounding environment to be usefully sustainable. Estimating this is best undertaken through modelling developed on the basis of the understanding of the pertinent geological and hydrological environment.

7. CONCLUDING REMARKS

Geoheat is low hanging fruit in support of New Zealand's energy transition, however it is slow to be taken up. Some of this is to do with the general lack of technology awareness and some to do with the presence of the very hot geothermal resources in the TVZ and at Ngawha that overshadows perceptions and understanding of lower temperature geothermal opportunities.

Public sector support for raising public awareness has been slow on the uptake. Progress only has really started to be made after 2021 / 2022. The Government is starting to get it, with the MBIE Draft Geothermal Strategy (MBIE 2025) released in July 2025 including material on Geoheat.

Some modest investment in Geoheat by the Government could assist with risk reduction and with the provision of financial support mechanisms immediate benefit for businesses, regions and for New Zealand can be achieved. Supportive implementation policies and enablers could also be established that support the uptake of low temperature geothermal emissions friendly technologies.

The EECA BOP RETA marginal abatement cost analysis identified geothermal, including ambient and low temperature geothermal, as the optimum fuel for all the sites studied as part of the BOP RETA.

MPI has started to see the potential of ambient and low temperature geothermal and is investing through the SFFF in the development of tools to assist greenhouse owners in considering Geoheat energy options to replace the fossil systems that are currently in use.

The BOPRC and Priority One are working to increase the awareness of ambient and low temperature geothermal available from the large TGS and the associated benefits from adopting Geoheat.

The New Zealand Geothermal Association and EECA have released a Geoheat Business Guide in Aotearoa New Zealand: Navigating Technology Options & Resource Management (NZGA / EECA 2025) seeking to assist in pointing businesses towards the opportunity to use low temperature Geoheat solutions.

Geoheat, across the temperature range, has much to offer in being a widely available local energy source with the potential to have significant positive benefits to the wider New Zealand energy system(s), particularly the wider electrical grid.

There are:

- Reduced CO_2e emissions;
- Reduced peak demands with the potential for smaller electrical grid upgrade requirements;
- Heat pumps allow smart renewable energy integration and thermal storage that can further alleviate strain on the grid;
- Local energy with associated energy security from certainty of supply and ongoing annual energy savings;
- Infrastructure approach to heating/cooling provides broader grid benefits through diversity, load sharing and system control
- Future energy price path certainty
- Improved local air quality with no on site combustion;
- Potential emission trading scheme cost savings.

There is urgency in other nations across the globe to develop low temperature geothermal. Much of this is focussed on heat pump technology and we benefit from the advancements that are occurring, particularly in Europe, from heat pump technology innovation.

There are positive moves in the BOP Region and the greenhouse sector in New Zealand to consider the benefits that ambient and low temperature geothermal can provide.

There is much more that is needed for and across New Zealand as a whole to "get it" and to enjoy the widely available benefits of ambient and low temperature geothermal, Geoheat.

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