

Case Study 3:

Energy Economics of Geoheat Use in High Temperature Geothermal System

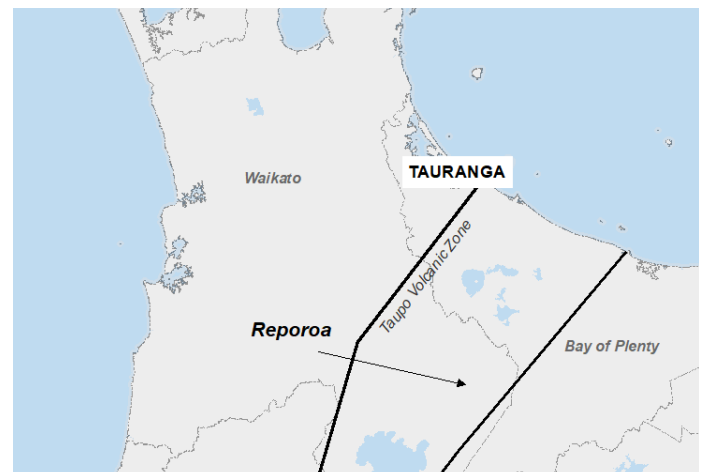
Location:

Reporoa, Waikato

Reporoa sits within the Reporoa Caldera, in the proximity of numerous high temperature geothermal systems, within the Taupō Volcanic Zone.

Based on expert resource assessment, hot temperatures are available at relatively shallow depths and have been included in this analysis.

Early engagement with Waikato Regional Council is recommended for anyone considering development here.



Purpose of Case Study

This case study is one of three developed for the *Geoheat for Greenhouse* project.

The purpose of this series of case studies is twofold. First, they demonstrate that geothermal energy solutions are highly site-specific. In some locations, the resource is so favourable that drilling for heat and implementing a direct-use open-loop system is the most economical option. In others, accessing shallow ambient groundwater resource provides the most cost-effective solution. A further complication is that there are multiple viable energy options at each site, ultimately, the optimal choice depends not only on site conditions but also on the grower's business model.

The second purpose of these case studies is to illustrate the range of outcomes that are available through the

Geoheat for Greenhouses Calculator tool. This tool will allow growers to adjust key inputs — such as glasshouse size, thermal envelope, location and climate, energy costs, depth-to-temperature, and groundwater flow rates — to understand how these variables influence energy performance and cost.

For this reason, the background logic and assumptions used in these case studies have been included to help users understand which factors most influence the final outcomes for different energy options. This tool has been developed by a team of geothermal energy experts, it is intended for educational purposes and it does not replace expert site specific analysis.

Abbreviations:

GSHP:
Ground Source Heat Pump

ASHP:
Air Source Heat Pump

Opex:
Operating expenses

LCOH:
Levelised Cost of Heat



Results:

The following tables show the economic and energy comparisons between gas heating systems (commonly used in greenhouses), air sourced heat pumps, and two potential geoheat heating systems using 70 °C directly.

High temperatures (exceeding the 70 °C required for direct use) are available at relatively shallow depths in this area. However, the exact drilling depth needed can only be confirmed through site-specific exploration. To assess this, the potential minimum and maximum drilling depths and their associated business cases have been presented.

Scenario 1 – New, 5 ha Greenhouse with Standard Thermal Envelope

	Annual thermal load (kWh)	Peak load (kW)	Capital cost	Annual Energy Consumption (kWh)	25 year Opex	Annual Carbon Emissions (kg CO ₂ e)	25 year carbon tax*	LCOH (\$ / kWh)
LPG Gas heaters			\$9,917,487	14,574,586	\$146,321,669	3,179,592	\$5,087,347	\$0.47
ASHP	12,939,900	7,791	\$10,120,053	5,881,773	\$68,407,989	411,724	\$658,759	\$0.22
Direct use (50 °C)			\$14,374,321	80,457	\$935,750	5,632	\$9,011	\$0.02
Direct use (70 °C)			\$13,150,146	80,457	\$935,750	5,632	\$9,011	\$0.02

Scenario 2 – New, 5 ha Greenhouse with Improved Thermal Envelope

	Annual thermal load (kWh)	Peak load (kW)	Capital cost	Annual Energy Consumption (kWh)	25 year Opex	Annual Carbon Emissions (kg CO ₂ e)	25 year carbon tax*	LCOH (\$ / kWh)
LPG Gas heaters			\$11,994,117	9,550,708	\$95,884,404	2,083,582	\$3,333,732	\$0.47
ASHP	8,479,500	5,464	\$12,136,181	3,854,318	\$44,827,668	269,802	\$431,684	\$0.22
Direct use (50 °C)			\$15,123,995	52,725	\$613,217	3,691	\$5,905	\$0.02
Direct use (70 °C)			\$14,265,452	52,725	\$613,217	3,691	\$5,905	\$0.02

These tables show the efficiencies gains through investing in both an improved thermal envelope, and an efficient heating technology.

While there is a shallow, hot resource in this area, a conservative flow rate of 15 L/s has been used in the analysis to reflect the variable availability of groundwater flow. This assumption impacts system performance and highlights the importance of adequate flow rates for geoheat efficiency. A site-specific investigation would be required to confirm actual flow conditions.

The Levelised Cost of Heat (LCOH) represents the average cost of producing heat over time. It combines installation costs, running costs (including allowances for energy inflation and carbon taxes), and forecast equipment replacements into a single average cost per unit of heat. Electrical upgrade costs, which may be required for electric options, are excluded.

More details into the parameters used in this assessment are described in more detail in the following pages.



Comparison of Annual Opex

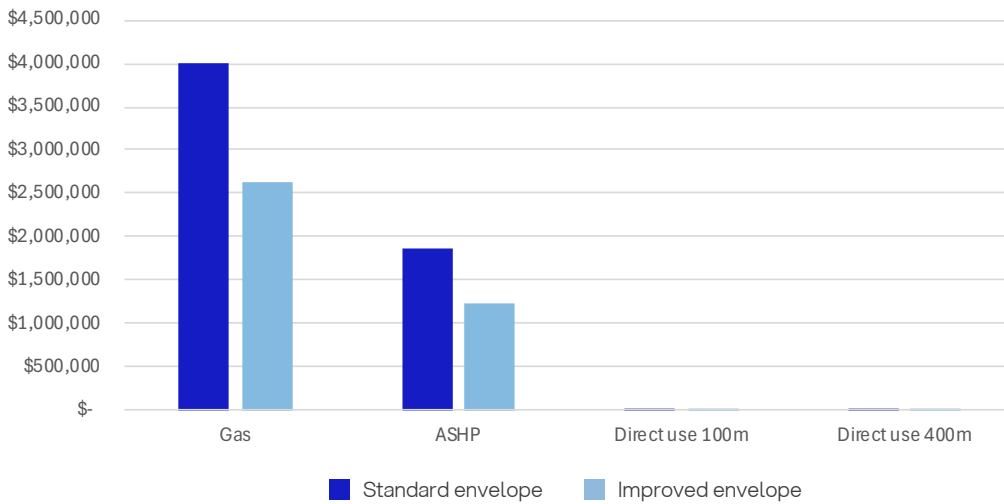


Figure 1: This graph shows the impact of smart building design on energy required for the operation of a greenhouses, comparing thermally insulated material (light blue) and traditional building material (blue). Large savings in energy costs can be achieved by investing in improved building material.

Assumptions and Design Choices for the Greenhouse Models

- ▶ Heating options: Capital costs for installing a new gas boiler, ASHP, and geothermal direct use system are compared delivering the same heating requirements for each thermal envelope scenario. GSHP has been excluded as it is not needed in naturally occurring high geothermal temperatures system.
- ▶ Greenhouse type: This model assumes a new build greenhouse, with different thermal envelope scenarios to demonstrate the impact that thermal efficiency has on operational energy cost (shown in figure above).
 - ▷ Standard envelope → higher heat losses, reducing system efficiency.
4mm toughened diffused glass
 - ▷ Improved envelope → improved efficiency; requires additional investment which has been included in the LCOH analysis (approx. 30% additional capital investment per m²).
Polycarbonate 16mm (White) U-Value 2.27 SHGC 0.66.
- ▶ Size: Analysis is based on 5-hectare greenhouse. Larger or smaller facilities can scale results by number of hectares (not exact but directionally useful).
- ▶ Internal set point: 18 °C
- ▶ Energy demand: The simulated glasshouse has a peak heating load of approximately 7,791 kW and an annual heating demand of 12,939,900 kWh for a standard thermal envelope. For the improved thermal envelope, the peak load reduces to around 5,464 kW with an annual demand of 8,479,500 kWh.
- ▶ Fuel costs: prices sourced from horticulture industry bodies, July 2025.
 - ▷ LPG Gas Cost: 0.275/ kWhr
 - ▷ Electricity Cost: \$0.319/ kWhr
 - ▷ Energy Inflation: 5 % per annum
 - ▷ Carbon tax: NZD \$64 per tonne CO₂-e
- ▶ Plant Operation: 24/7 heating availability
- ▶ Analysis period: 25 years
- ▶ Replacement: ASHP 15 years, GSHP and boilers typically every 25 years. Geothermal direct use equipment will not need a replacement in a 25 year period.
- ▶ Electrical Supply Considerations: cost for electrical supply equipment (e.g. transformers) has been excluded in this analysis for the ASHP option. Upgrade costs can be significant and impact the business case for the electric options, however, they can only be determined on a case-by-case basis.



Assumptions and Design Choices Related to Geothermal Heating System Models

Groundwater

- ▶ Flow rates: good flow rate (defined as number of litres per second) is essential for a geothermal system, especially an open loop system. For the purposes of this case study, our team has done a desktop assessment and we know the groundwater flow rate is sufficient for intended purposes at this site. The higher the flow rate, the more effective a geothermal system is. An average flow rate of 15 litres per second has been included in calculations. Growers may be able to determine their flow rates from irrigation bores they have on site.
- ▶ Open or closed loop system: flow rates are sufficient to ensure that use of the resource will not result in adverse effects the geothermal system. An open loop system has been selected.
- ▶ Well Design: for geothermal open loop designs, more reinjection wells than abstraction wells are required. This ensures that recharge to the aquifer is sustainable.
- ▶ Number of wells: Combined 39 abstraction and reinjection wells are modelled for the standard envelope and 27 for the improved envelope. The reduced number of wells required to heat the improved envelope scenario, reduces the capital investment requirement, even though more is spent on the improved envelope.

Climate

Site-specific climate conditions, including the number of frost days and total sunshine hours, have been included in the analysis to accurately reflect their impact on thermal demand.

Geothermal Source Temperatures

As this is a high temperature system zone, GSHP and direct use systems using 50°C are not included as options.

- ▶ Direct use @ 70 °C → simple pipe network distributes high heat across the facility to maintain set point of 18°C.
- ▶ Test well: For all geoheat installations, an initial test well is required to determine the depth that delivers the optimal flow rates and temperatures, both of which are critical to overall system performance. This test well is then incorporated into the final operating system as a productive well.

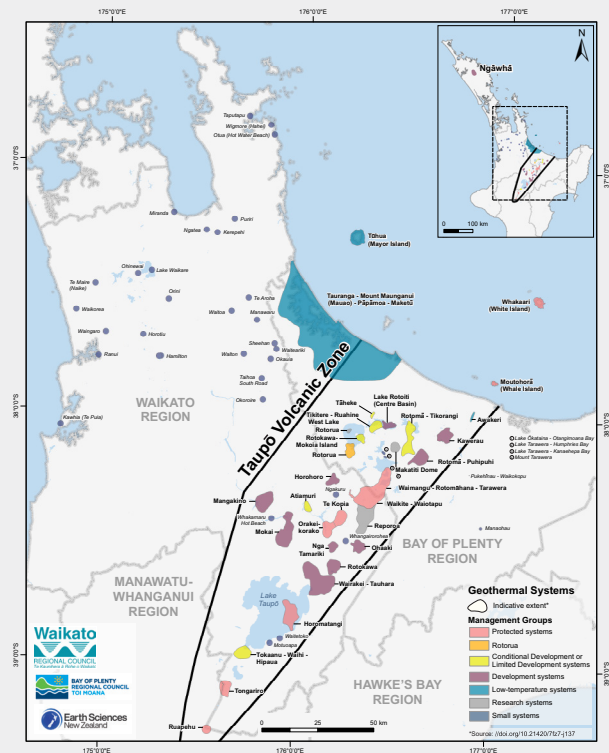


Figure 2. Reporoa (coloured grey) is one of many high temperature fields in the Taupo Volcanic Zone.

Summary

There is strong potential in this high-temperature geothermal field to support larger greenhouse developments. However, uncertainty remains around groundwater flow rates and the exact depths at which target temperatures are reached. As a result, the findings in this 5 ha case study should be viewed as conservative estimates. The final system design and financial analysis may change significantly once site-specific investigations are undertaken, particularly after a test well is drilled and its results are incorporated into the design process.

Disclaimer

The findings of this case study are derived from a high level desktop assessment using the online calculator logic and have been reviewed by expert professionals. Confirmation of results will require drilling, resource testing, and detailed system design. Results are intended to illustrate opportunities and reflect the background working that has built the assumptions of the Geoheat for Greenhouse calculator.