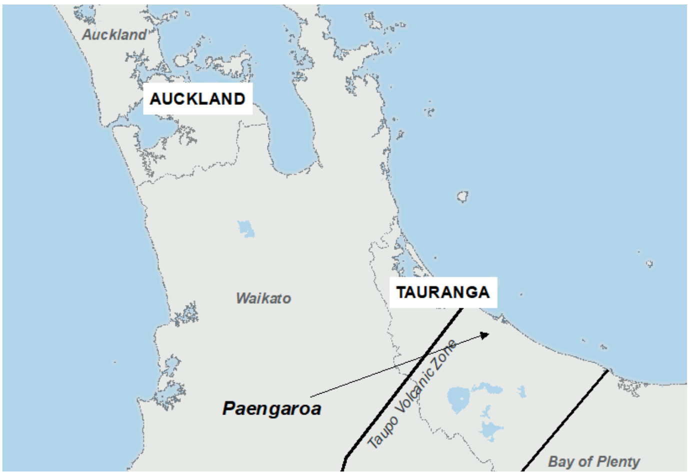
Case Study 1:

Energy Economics of Geoheat Use in Known Geothermal 'Warm Zone'

Location:

Paengaroa, Western Bay of Plenty

The site is located within the Tauranga Geothermal System (TGS). A review of nearby bores reveals that groundwater temperature in the order of 30 to 40°C are available 150 m below ground surface. Based on expert resource assessment, warmer temperatures are estimated to be available at greater depths and have been included in this analysis.



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 three potential geoheat heating systems (ambient shallow groundwater conditions, and two geothermally enhanced groundwater conditions found at deeper depths).

Scenario 1 – New, 0.8 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_2e)	25 year carbon tax*	LCOH ($ / kWh)
Gas heaters			$580,000	1,340,854	$13,461,517	292,521	$468,033	$0.49
ASHP			$1,050,000	541,120	$6,293,499	37,878	$60,605	$0.28
GSHP (20 °C)	1,190,464	945	$1,300,000	345,067	$4,013,306	24,155	$38,648	$0.18
Direct use (50 °C)			$1,750,000	7,402	$86,088	518	$829	$0.06
Direct use (70 °C)			$1,120,000	7,402	$86,088	518	$829	$0.04

Scenario 2 – New, 0.8 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_2e)	25 year carbon tax*	LCOH ($ / kWh)
Gas heaters			$580,000	837,178	$8,404,854	182,639	$292,222	$0.50
ASHP			$1,050,000	337,855	$3,929,419	23,650	$37,840	$0.33
GSHP (20 °C)	743,280	667	$1,300,000	215,447	$2,505,754	15,081	$24,130	$0.21
Direct use (50 °C)			$1,750,000	4,621	$53,750	324	$518	$0.10
Direct use (70 °C)			$1,470,000	4,621	$53,750	324	$518	$0.08

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

In the improved envelope scenario, although additional investment is required to enhance the thermal performance of the greenhouse, fewer bores are needed to meet the heating demand, effectively offsetting the extra capital cost.

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.

Comparison of Annual Opex

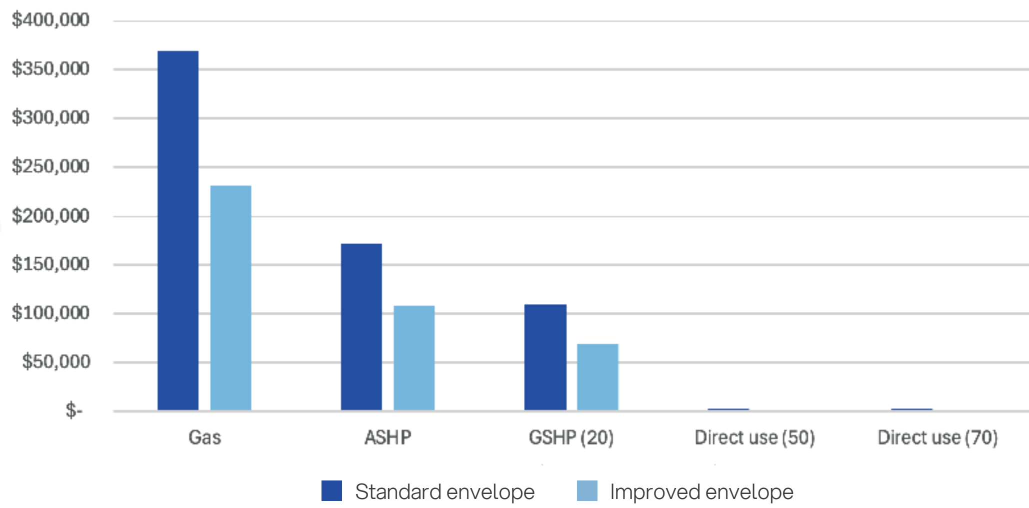


Figure 1: This graph shows the impact of smart building design on energy required for the operation of a greenhouses, comparing thermally insulated material (light blue) and traditional building material (blue). Large savings in energy costs can be achieved by investing in improved building material.

Assumptions and Design Choices for the Greenhouse Models

- **Heating options:** Capital costs for installing a new gas boiler, air source heat pump (ASHP), ground source heat pump (GSHP), and geothermal direct use system are compared delivering the same heating requirements for each thermal envelope scenario.
- **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 m^2).

    Polycarbonate 16mm (White) U-Value 2.27 SHGC 0.66.
- **Size:** Analysis is based on 0.8-hectare greenhouse. Larger 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 945 kW and an annual heating demand of 1,190,464 kWh for a standard thermal envelope. For the improved thermal envelope, the peak load reduces to around 667 kW with an annual demand of 743,280 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 CO_2-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 GSHP and ASHP options. Lower electrical demand for a GSHP reduces required upgrade scale and can mean an upgrade may be avoided entirely where spare capacity exists. 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. The higher the flow rate, the more effective a geothermal system is. An average flow rate of 25 litres per second has been included in the calculations, based on available data for this site. Growers may be able to determine their flow rates from irrigation bores they have on site.
- **Open or closed loop system:** An assessment of the groundwater aquifer size and flow rate ensures that both a open loop or a closed loop system could work at this site. An open loop system has been selected for both the ground source heat pump and direct use geothermal options in this case study.
- **Well Design:** for geothermal open loop designs, more reinjection wells than abstraction wells are required. This ensures that recharge to the aquifer is sustainable.

Geothermal Source Temperatures

- **Indirect use @ 20 °C →** a ground source heat pump boosts the source temperature to between 60 and 80 °C, to sustain an internal set point of 18°C.
- **Direct use @ 50 °C →** reflects international practice of targeting source temperatures of 40–45 °C. These lower source temperatures require increased internal pipe surface area to sustain 18C set point temperature.
  - Alternative is to boost source temperature with gas backup, biomass, waste oil, ASHP, or GSHP. These options were excluded to simplify this analysis.
- **Direct use @ 70 °C →** simple pipe network distributes high heat across the facility to maintain set point of 18°C. These temperatures reflect the operating source temperature commonly provided by gas or coal boilers.

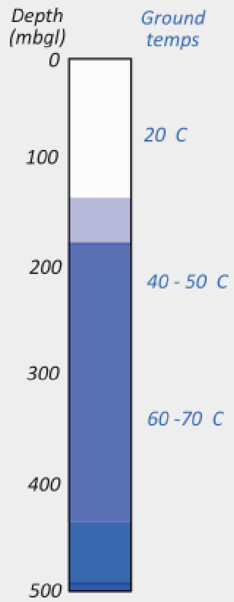


Figure 2. Range of target depths and associated temperature at site. Colours represent known sedimentary layers in the subsurface.

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.

Summary

The combination of favourable groundwater flow rates and comparatively shallow warm resources makes this a strong geoheat case study for the 0.8 ha greenhouse modelled. These results at this location are equally relevant for larger greenhouse developments. This case study compares the use of 50 °C and 70 °C groundwater to achieve the same heating outcomes, demonstrating that drilling only to reach 50 °C may be the most cost-effective option at some locations.

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