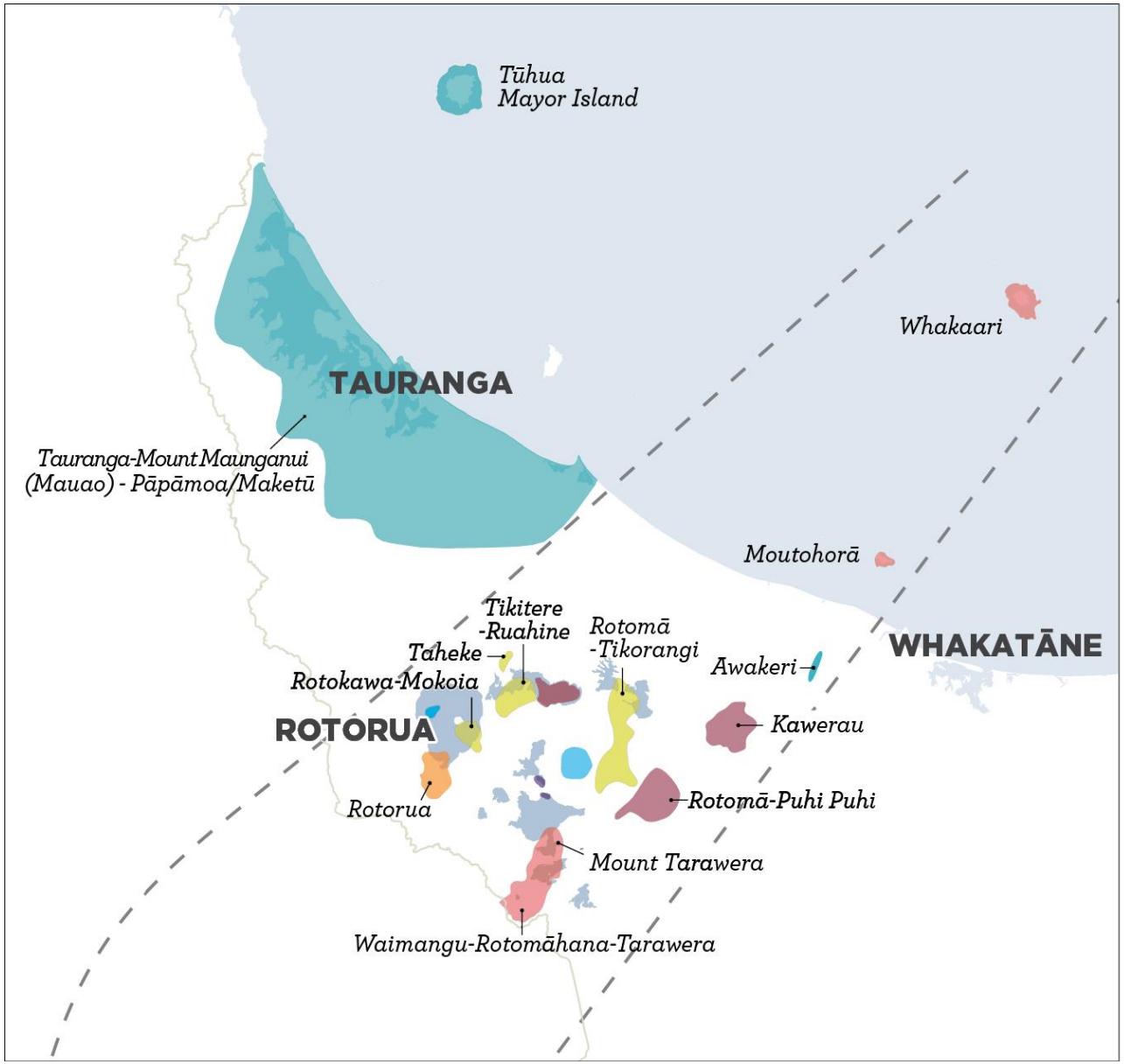
• Low Temperature GeoHeat

BAY OF PLENTY REGIONAL COUNCIL
TOI MOANA

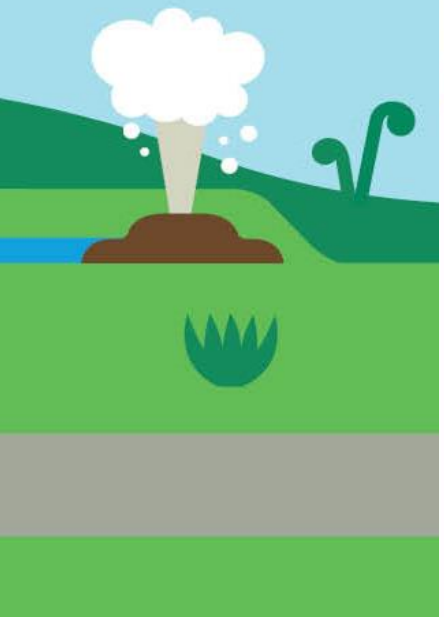
- Priority One information session
- 7 November 2024

• Geothermal systems



Council's role in geothermal

- Management of the geothermal resource under the Resource Management Act 1991:
  - Policy development
  - Resource consents for use of geothermal water, fluid and heat
  - Compliance
  - Monitoring (Science)
- Regional economic development - opportunities to leverage advantages from geothermal



Key workstreams

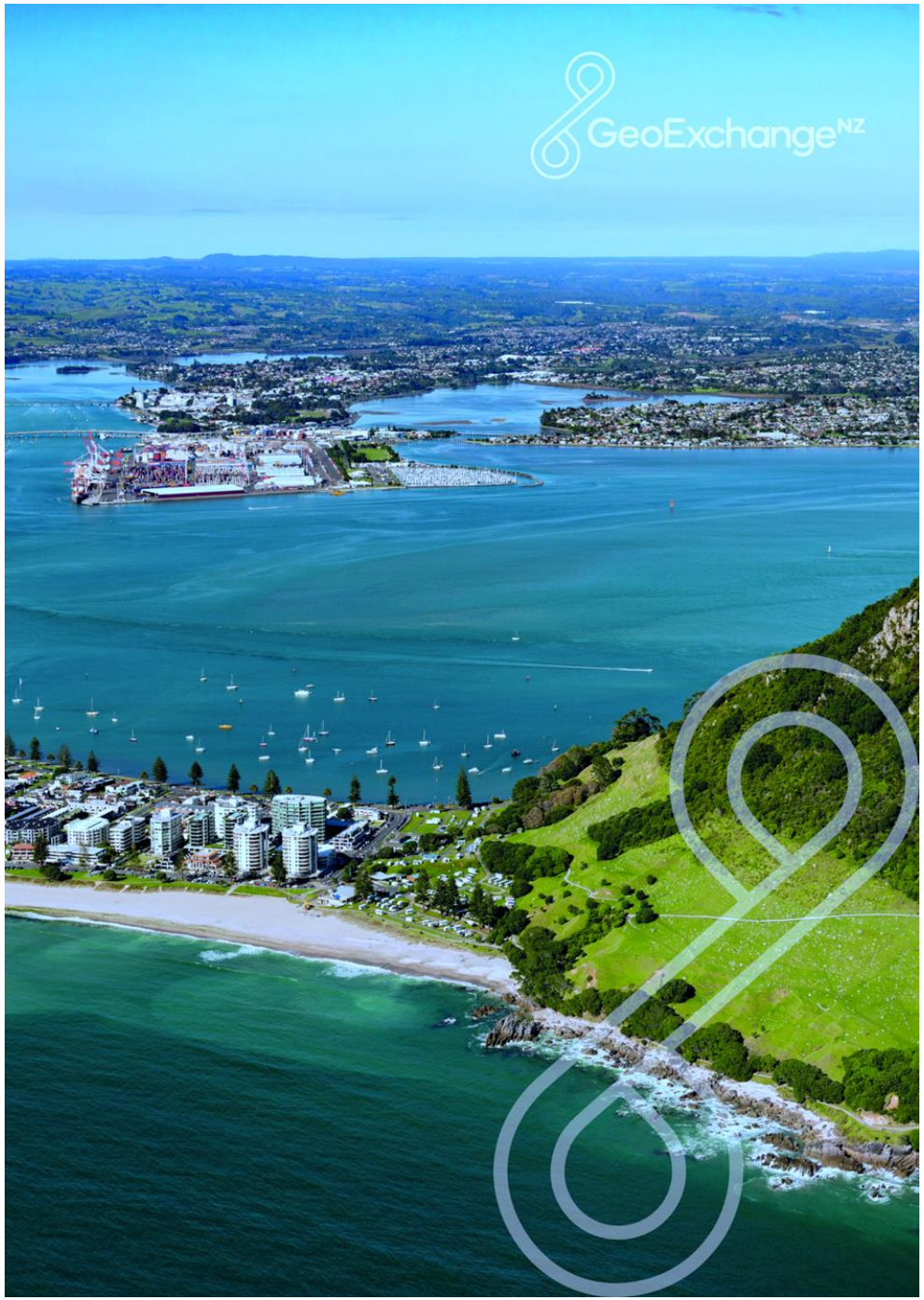
- Draft **Tauranga Geothermal System Management Plan** (SMP) - sustainable geothermal use and enabling renewable low carbon energy
- Support for EECA's **Bay of Plenty Regional Energy Transition Accelerator (RETA)** programme - opportunities to decarbonise industrial process heat
- **GeoHeat Potential of the Tauranga Geothermal System** report - opportunities for sustainable use of low temperature geothermal

For more information

- Geothermal reports and resources: www.boprc.govt.nz/environment/geothermal
- Feedback on the Draft Tauranga System Management Plan: www.participate.boprc.govt.nz
- Workshop on the Draft Tauranga SMP, **Tuesday 12 November**, 12.30-2.30pm, Tauranga Yacht Club

  RSVP: geothermal@boprc.govt.nz

- Contact: dean.howie@boprc.govt.nz



Geothermal Heat for Residential, Commercial and Industrial Use

Tauranga Geothermal System

Priority One
Tauranga
Moana

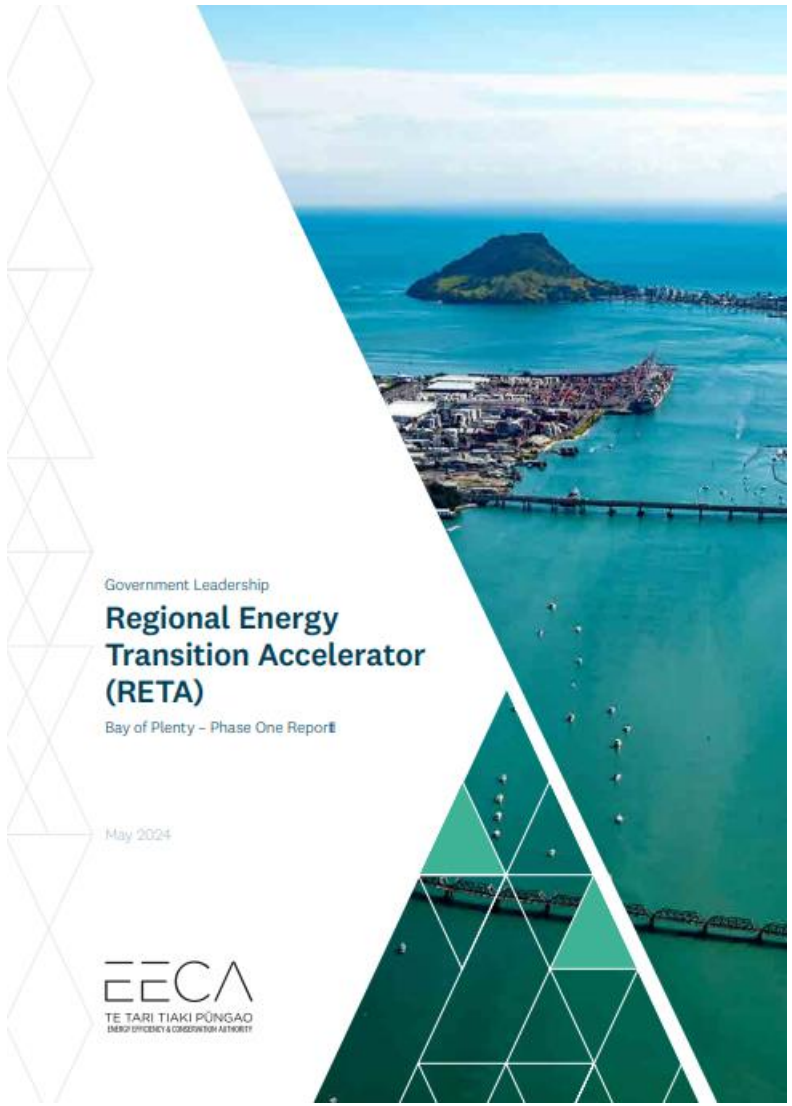
07 November 2024

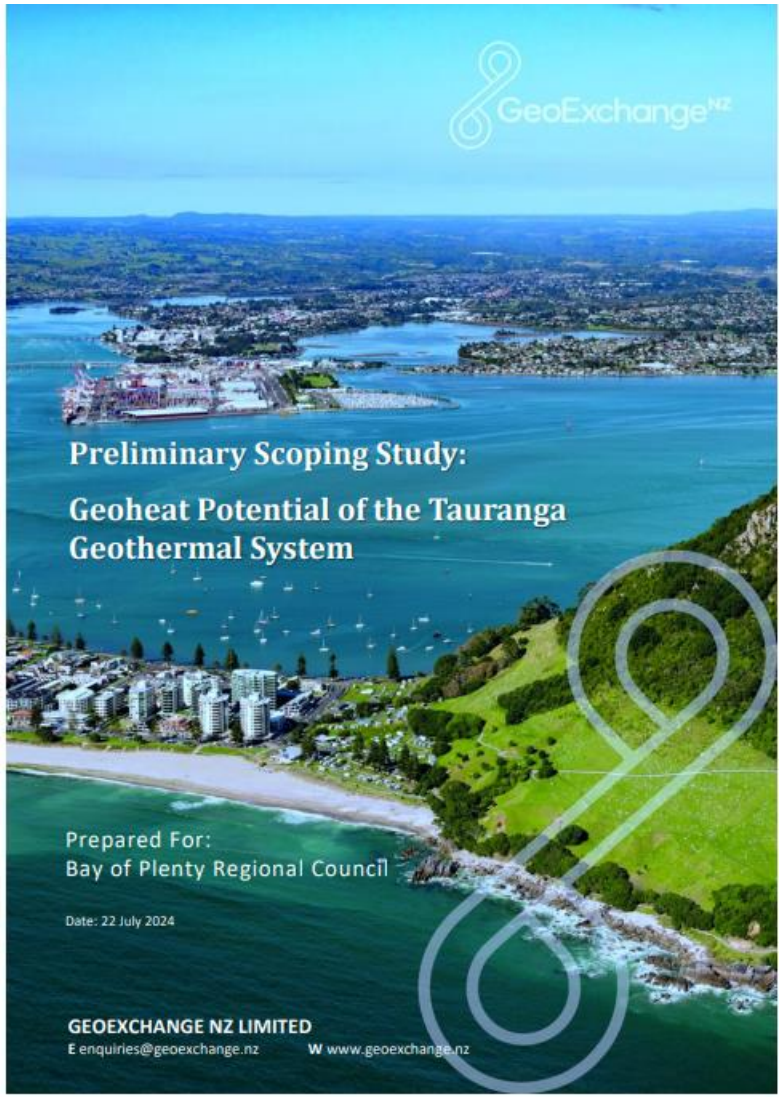
Prepared by Yale Carden and Celia Wells

Purpose of today's workshop

- Share the results of the 'GeoHeat Potential of the Tauranga Geothermal System' report
  - Focus on technological feasibility and
  - User applications

- We wont cover in detail resource consenting, see BOPRC workshop being hosted next week regarding the System Management Plan consultation.





Ministry for Primary Industries
Manatū Ahu Matua

Sustainable Food and Fibre Futures
Te anamata o ngā kai me ngā weuweu toitū

Vegetables NEW ZEALAND Inc

TomatoesNZ

Focusing Questions

Could the western Bay of Plenty use its comparatively shallow low temperature geothermal resource to its strategic advantage as the region develops?

AND

Importantly, how can this be done sustainably?

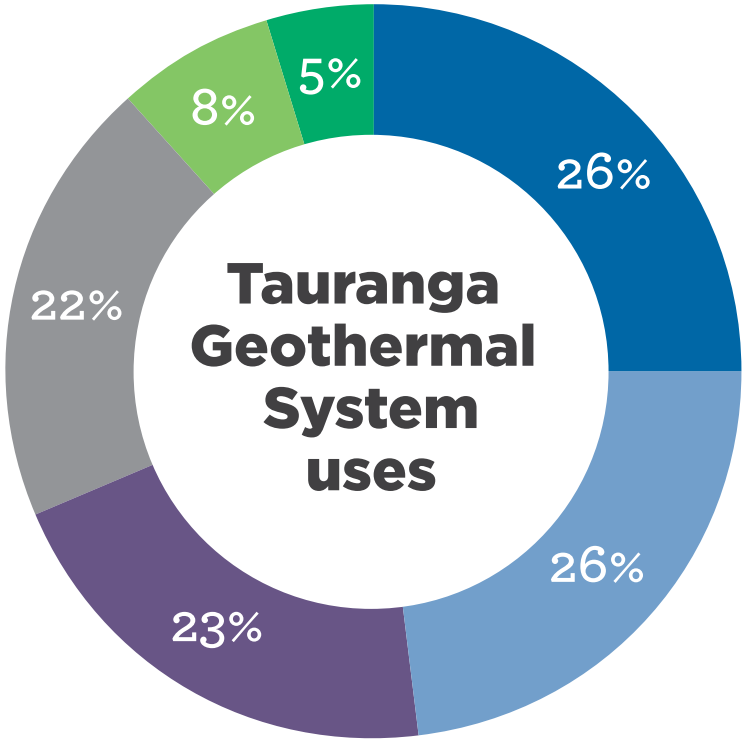
The TLDR Version

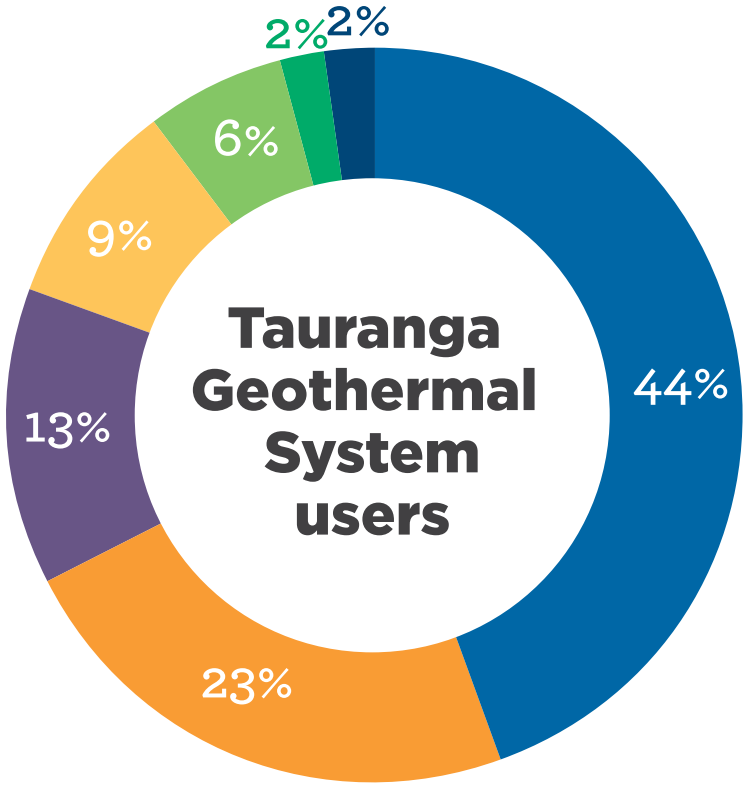
There is a really good low temperature geothermal resource present

Most people are not aware of it

Those that are aware of think that it is only suitable for heating pools

TGS: Uses and Users





- Water and space heating
- Mineral pool and heating
- Mineral pool
- Water heating
- Space heating
- Other
- Community facilities
- Private use
- Body corp, retirement village
- Tourism
- Horticulture
- Private horticulture
- Other

Defining Geoheat

- Geoheat systems are either:
  - **Direct Use:** Systems that use available geoheat directly (eg a geothermal hot pool); or
  - **Indirect Use:** Systems that require a heat pump to modify the source temperatures.

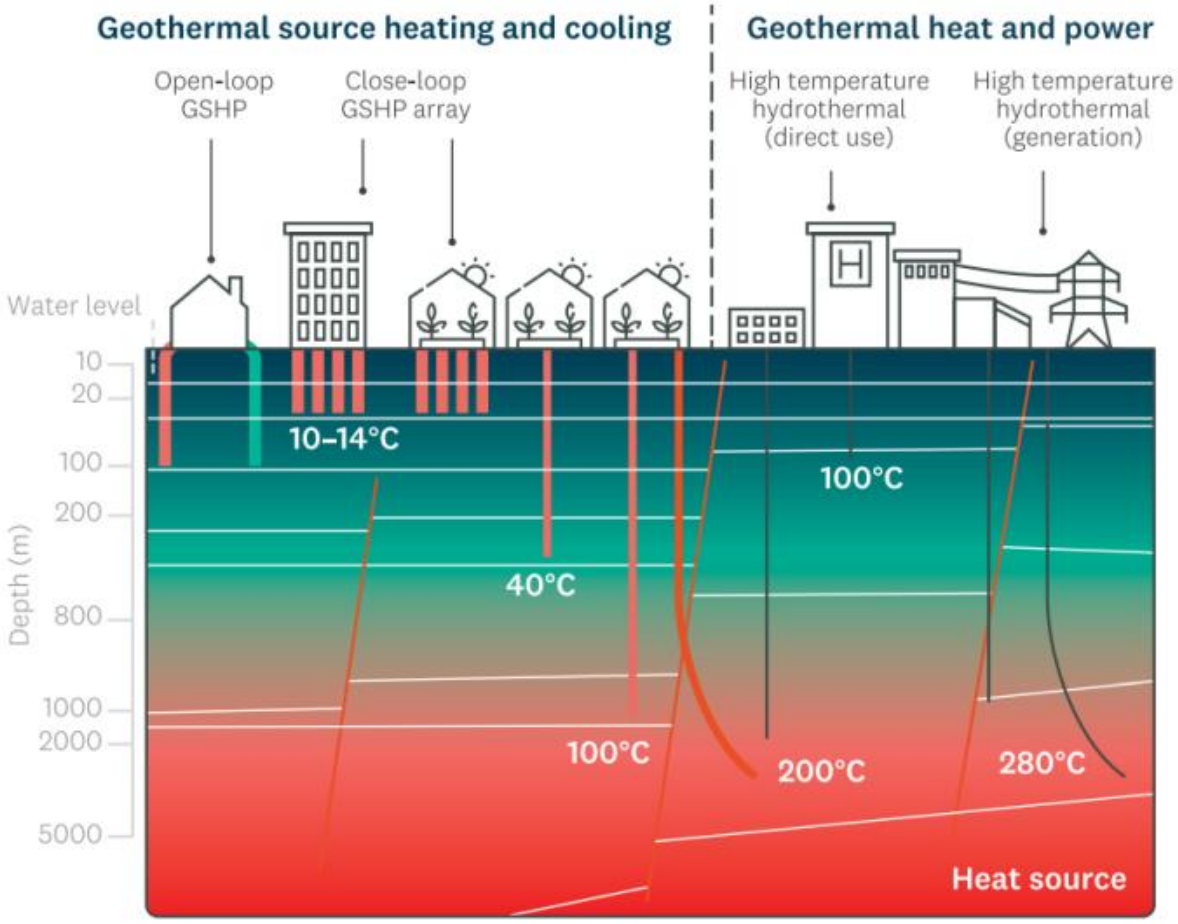
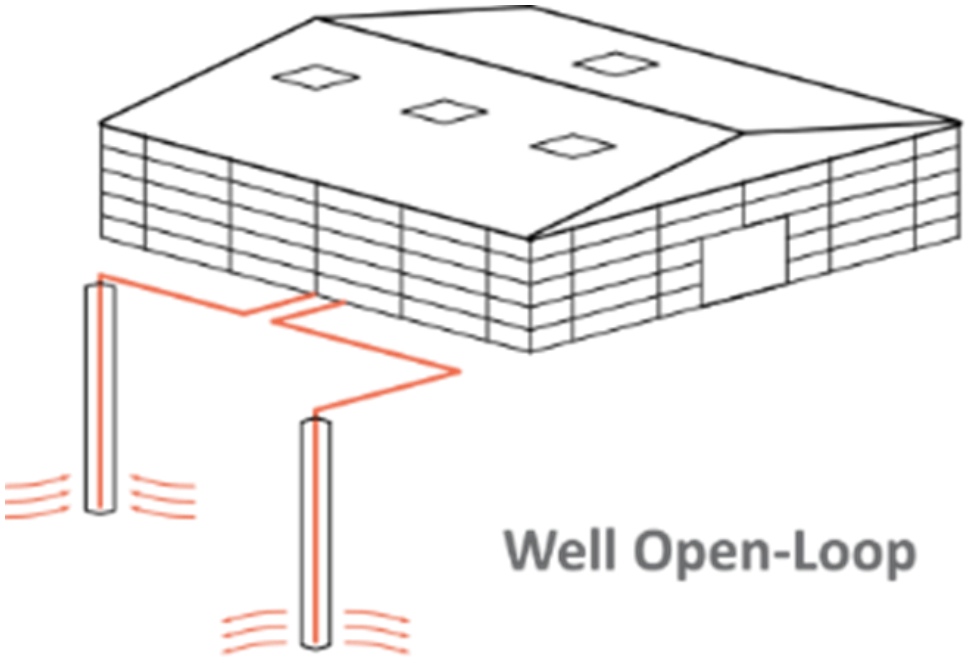
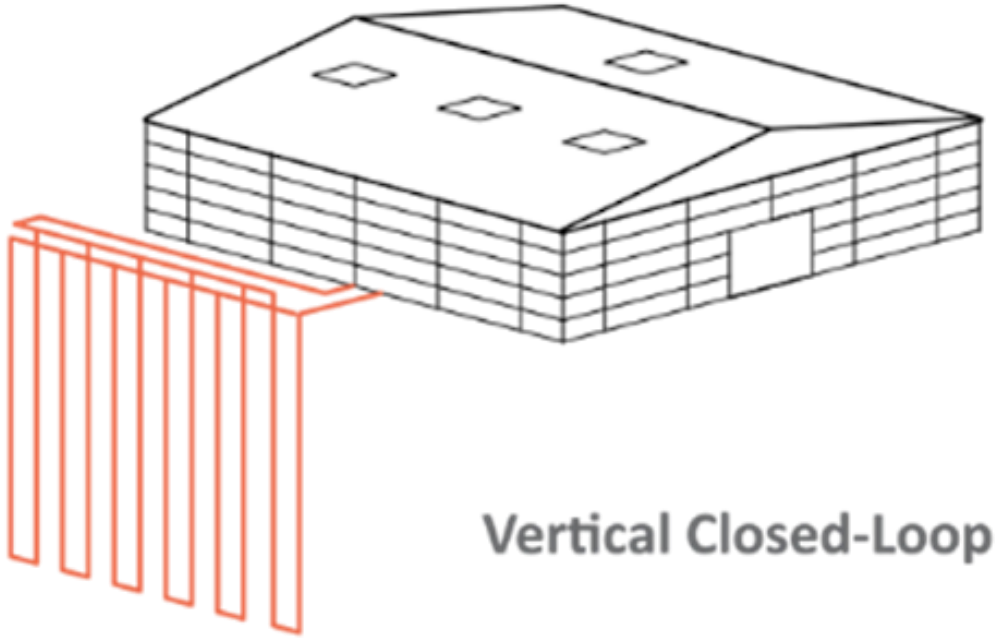


Figure 8: Example of Connection Between Various Geoheat Sources and Above Ground Applications. Source: GNS Science from EECA (2024)

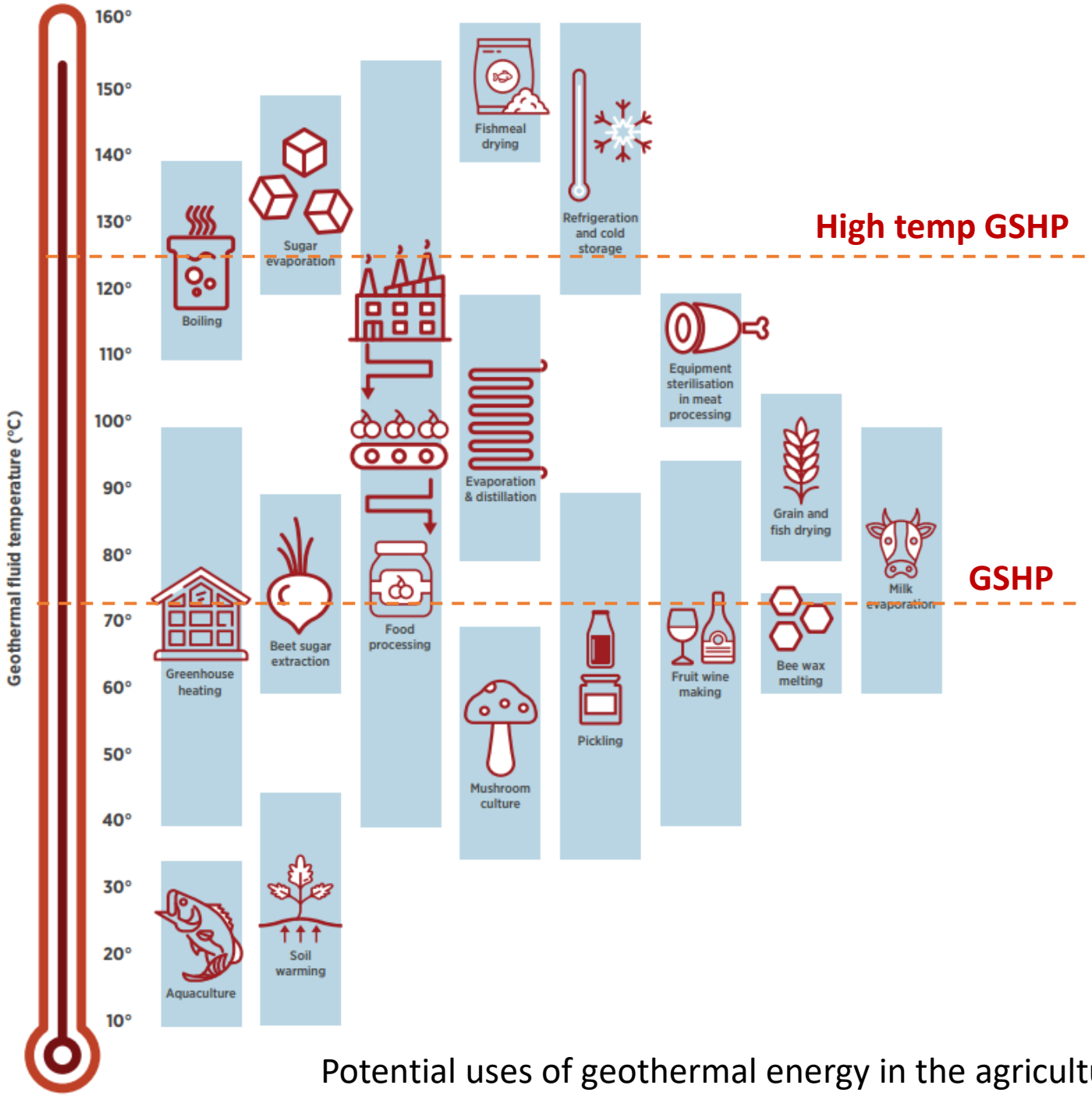
Open Loop and Closed Loop



Well Open-Loop



Vertical Closed-Loop

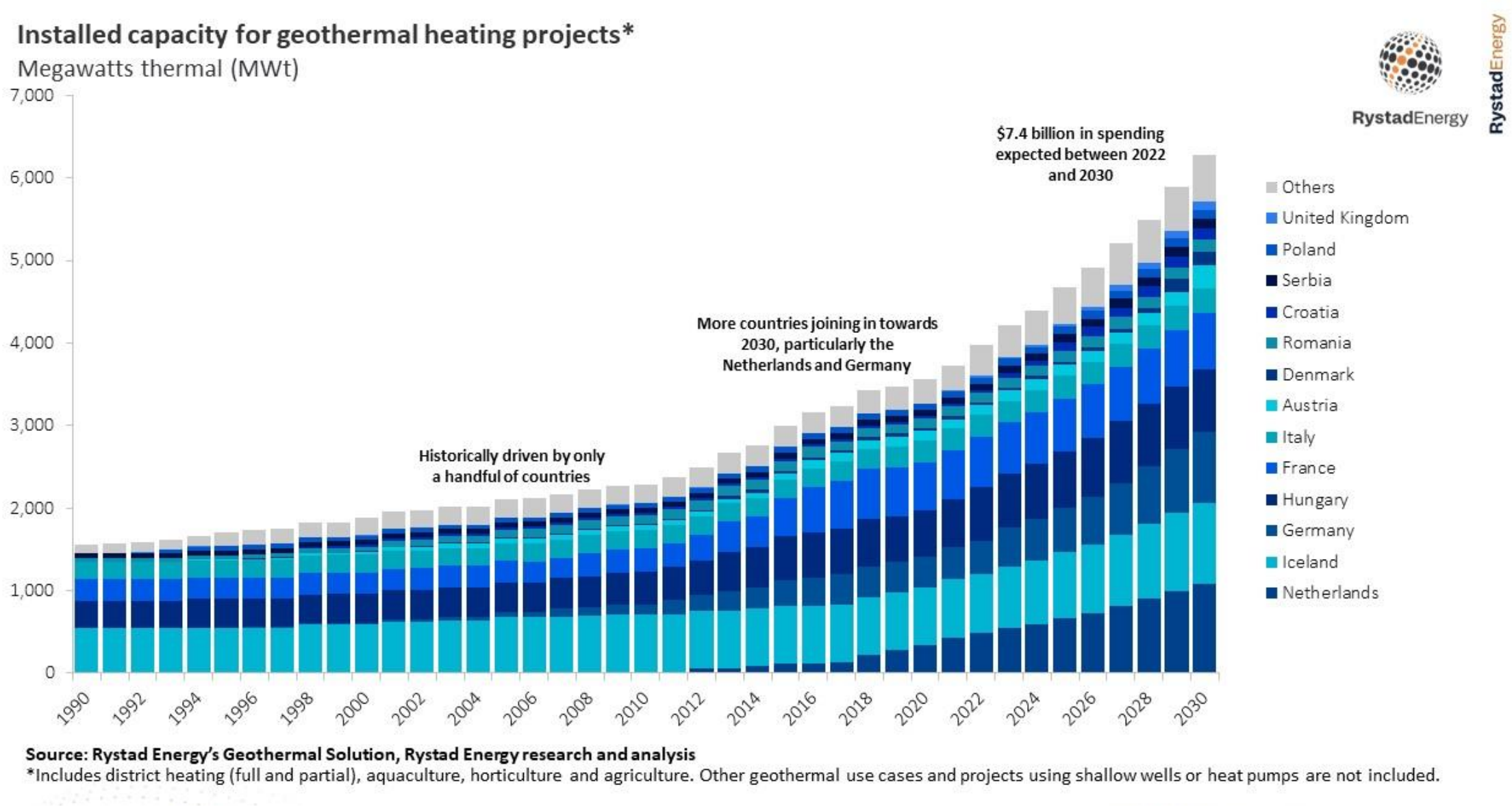


Potential uses of geothermal energy in the agriculture sector (IRENA, 2022)

GeoHeat's Appeal

- Unlike other renewables, a major benefit of geoheat is that it is not weather dependent, it sustainably generates heat 24/7.
- Unlike biofuels and hydrogen, geoheat does not need to be transported, stored on site, nor is it subject to supply constraints and fluctuating costs.
- Compatible with electrification and can reduce need to upgrade or invest in electrical infrastructure.

- But it is site specific, you need to be sitting above suitable resource (doesn't always mean geothermal heat).

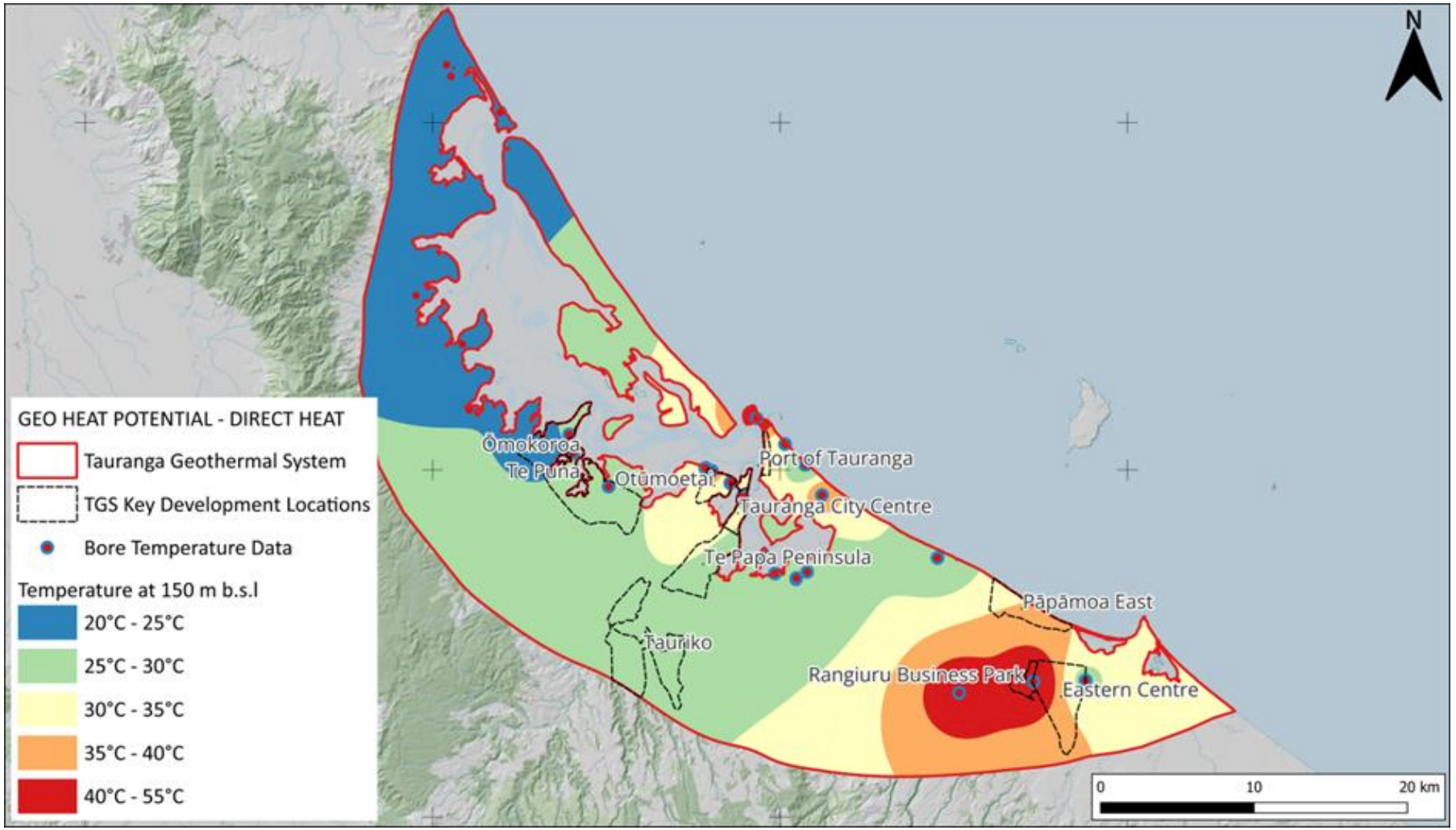


Source: Rystad Energy's Geothermal Solution, Rystad Energy research and analysis

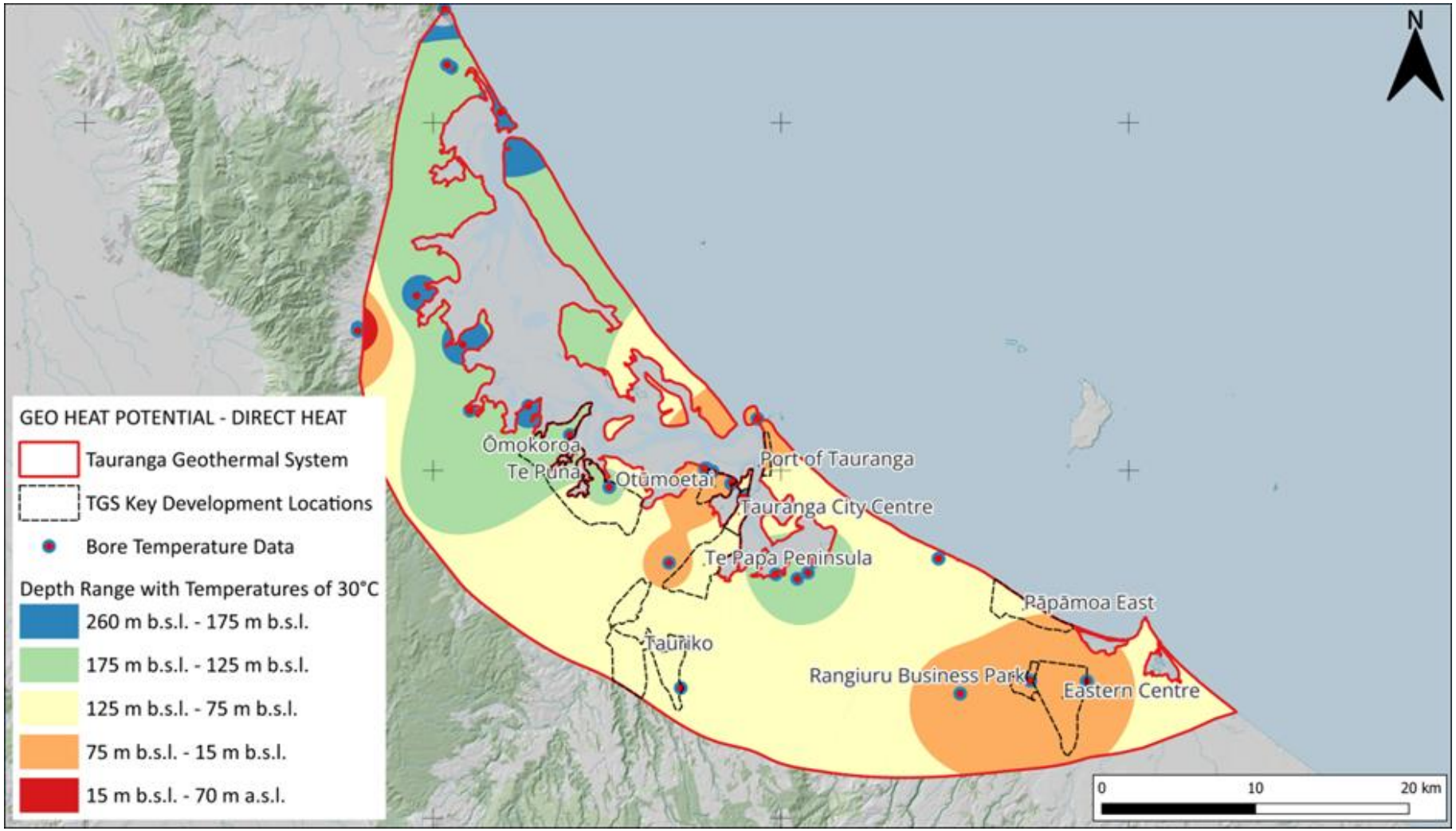
*Includes district heating (full and partial), aquaculture, horticulture and agriculture. Other geothermal use cases and projects using shallow wells or heat pumps are not included.

Europe to spend $7.4 billion on geothermal heating, capacity to reach 6.2 GWt by 2030

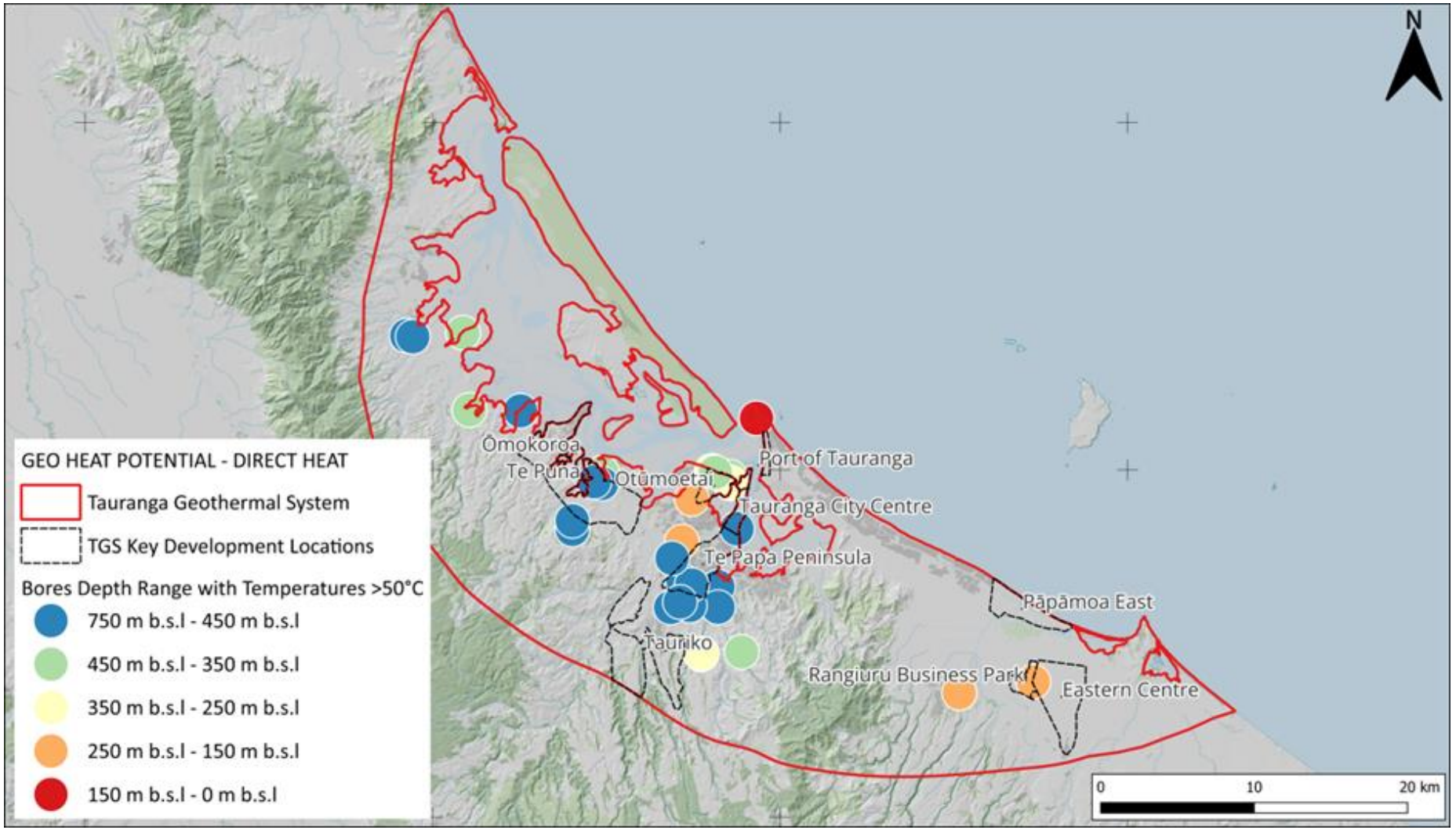
TGS: Temperature at 150m bsl



TGS: Depth of Temperatures >30°C



TGS: Depth of Temperatures >50°C

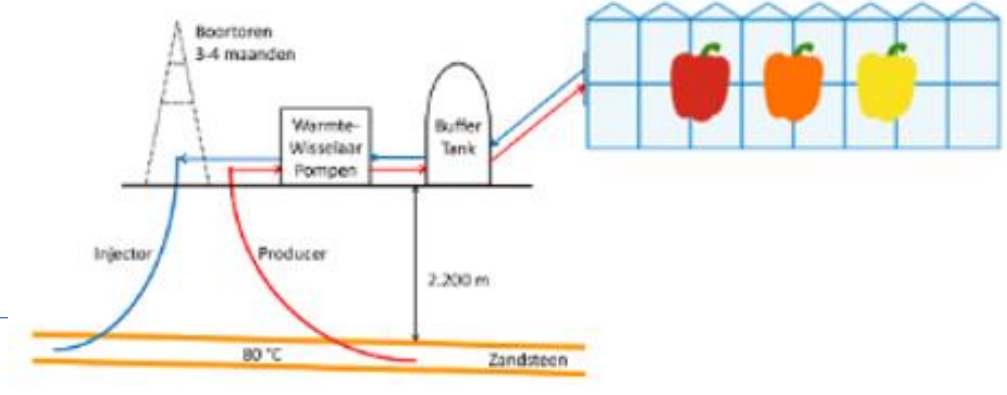


TGS: Potential Development Zones

Depth Range of Ground Temperatures Underlying the Potential Development Zones			
Potential Development Zone	**Land Use Zoning**	**Depth Range Encountered**	
		30°C	**50°C**
Port of Tauranga	Industrial	<125 m b.s.l	<500 m b.s.l
City Centre	Mixed Use: Residential / Commercial	<125 m b.s.l	<500 m b.s.l
Te Papa Peninsula	Mixed Use: Residential / Commercial	<125 m b.s.l	<600 m b.s.l
Tauriko	Residential	<125 m b.s.l	<700 m b.s.l
	Industrial		
Rangiuru Business Park	Industrial	<75 m b.s.l	<200 m b.s.l
Eastern Centre	Residential	<75 m b.s.l	<200 m b.s.l
Ōmokoroa / Te Puna	Residential	<175 m b.s.l	<500 m b.s.l
	Industrial		
Otūmoetai	Residential	<75 m b.s.l	<450 m b.s.l
Pāpāmoa East	Residential	<125 m b.s.l	>150 m b.s.l
Note: Anticipated average depth range in which the temperature value was measured within the potential development zone.			

Direct Use – Low Temperature Geothermal <150°C

- Hoogweg capsicum greenhouse
- 160 ha of greenhouse
- 1 production well, 2 reinjection and expanding
- Geothermal is supplemented with biomass
  2 x 15 MW boilers



District Scheme - Munich

- **Example of geothermal ‘Direct use’ at a district scheme scale.**
- Munich is targeting 100% of its district heating from renewable energies by 2040, geothermal heat is the backbone of the heat supply.
- Six deep wells.
- Drilling depth of approx. 2.5 km in the north to reach a reservoir temp 60°C
- Depth of approx. 5 km south to reach a reservoir temp of 150°C (Farquharson N. et al., 2016).
- District cooling now being added.

Geo Heatpumps

An important finding of the work for BOPRC is that heat pump assisted geoheat installations (referred to as indirect use) are well suited to the TGS.

Australian War Memorial

- Ground-source heat pumps will utilise geothermal energy for **heating and cooling**, replacing existing gas and electric boilers.
- 216 vertical closed-loop boreholes drilled to depths of up to 150 meters.
- The system is expected to reduce emission by **1400 tonnes of CO2 equivalent** per year and save the Memorial up to **$1 million each year in energy costs compared to the previous system.**

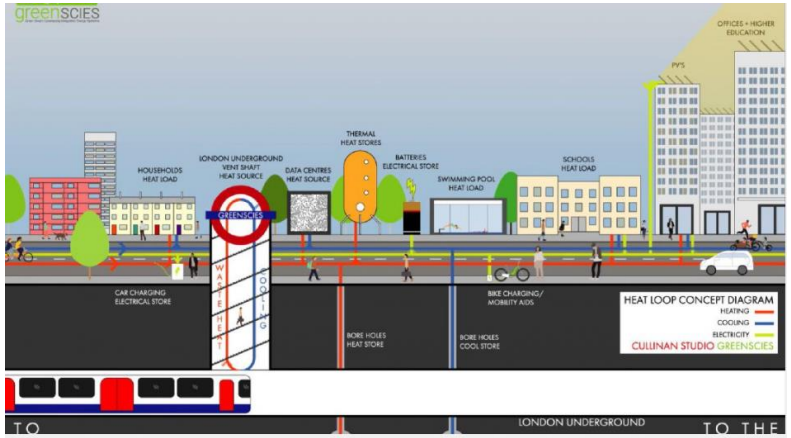
GeoExchange projects in UK

Hammersmith and Fulham, London

GreenSCIES, Islington, London

https://www.lbhf.gov.uk/civic-campus

https://www.islington.gov.uk/environment-and-energy/energy/greenscies



District Scheme - Vienna

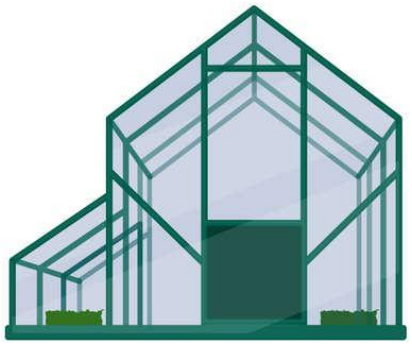
- **Example of geothermal ‘indirect use’ at a district scheme scale.**
- Vienna’s Simmering district
- Three large heat pumps have been commissioned
- They will provide heating for 56,000 households
- Thermal energy from purified wastewater
- The capacity is set to be doubled by 2027 - 110 MW

Tomatoes in Slovenia

- Groundwater source temp 30-40 °C from 1500m
- Delivers between 65-85 °C
- Heating capacity of 2000kW
- COP between 5 - 6
- Installed in 2018
- Savings up to 70% compared with gas
- ROI < 1 year
- GSHP is the second most efficient way to heat after direct geothermal.

Influence of Geothermally Enhanced Groundwater

Influence of Geothermally Enhanced Groundwaters on System Performance				
Heat Pump Type (Source Temperature)	**System COP**	**Electrical Input (kWe)**	**Energy Cost[1] ($)**	**Savings**
ASHP (0 'C)	2.0	2460	$1,215,320	--
GSHP (10 'C)	2.4	2000	$1,012,767	$202,554 (17%)
GSHP (15'C) **X**	2.77	1733	$877,488	$337,833 (28%)
GSHP (20 'C)	3.2	1500	$759,575	$455,745 (38%)
GSHP (25 'C)	3.6	1333	$675,178	$540,142 (44%)
GSHP (30 'C)	4.0	1200	$607,660	$607,660 (50%)
Note 1: Energy cost at 26c/kWh and excludes maintenance etc				



High Temperature Heat Pumps

"Industrial heat pumps can provide energy at temperature levels of up to 160°C.

Prototypes are operating at around 180°C and industry experts expect temperatures of 200°C and beyond in this decade."

European Heat Pump Association AISBL, 2024

EECA Technology Demonstration Fund

Technology Demonstration Fund RFP Announcement:

- **Very high temperature heat pump demonstration**
- $4 mill available
- Closes 12 Dec
- Temp demand >100 °C
- Targeting output of ≤5MWth

HTHP Wienerberger Brick, Austria

High temperature heat pump (HTHP) replaces gas.

- Heat source : waste heat source is 90°C water that is produced by air-to-water heat exchangers located remotely in the kiln and dryer air exhausts.
- Heat delivery : the heat pump supplies hot air at 110°C to 160°C back to the brick dryer.
- The heat pump was installed in 2019. After more than 4000 hours of operation, energy savings add up to around 80% and have resulted in a reduction in CO_2 emissions of about 80%.
- It provides 296 kW at a COP of 5.0

Takaoka Toko Transformers, Japan

High temperature heat pump (HTHP) replaces gas.

- Producers of electric transformers. During manufacturing, transformers are coated with a special resin that is heated and dried. Since 2012, a high temperature heat pump has been used for this process.
- Heat source : 55°C water.
- Heat delivery : the heat pump produces 130°C pressurized water that is fed to a water-to-air heat exchanger located at the transformer dryer inlet. This heat exchanger provides 125°C hot air to the dryer.
- As a positive side effect of using dry air versus steam, drying time was reduced by 3 days.
- Energy and CO_2 emissions savings around 65%.
- It provides 627 kW at a COP of 3.0.

Port of Tauranga industrial site

- High temperature GSHP utilising a geothermally enhanced aquifer
  - 45-55°C at 300m
- Facility currently uses gas for electricity generation and industrial heating (co-generation)
- Distinct operation to analyse –
  - Two Fluid Bed Dryers that receive steam directly from the boiler and require a combined total of 900kg/h steam at 120°C

Modelled Outcome - Port of Tauranga industrial site

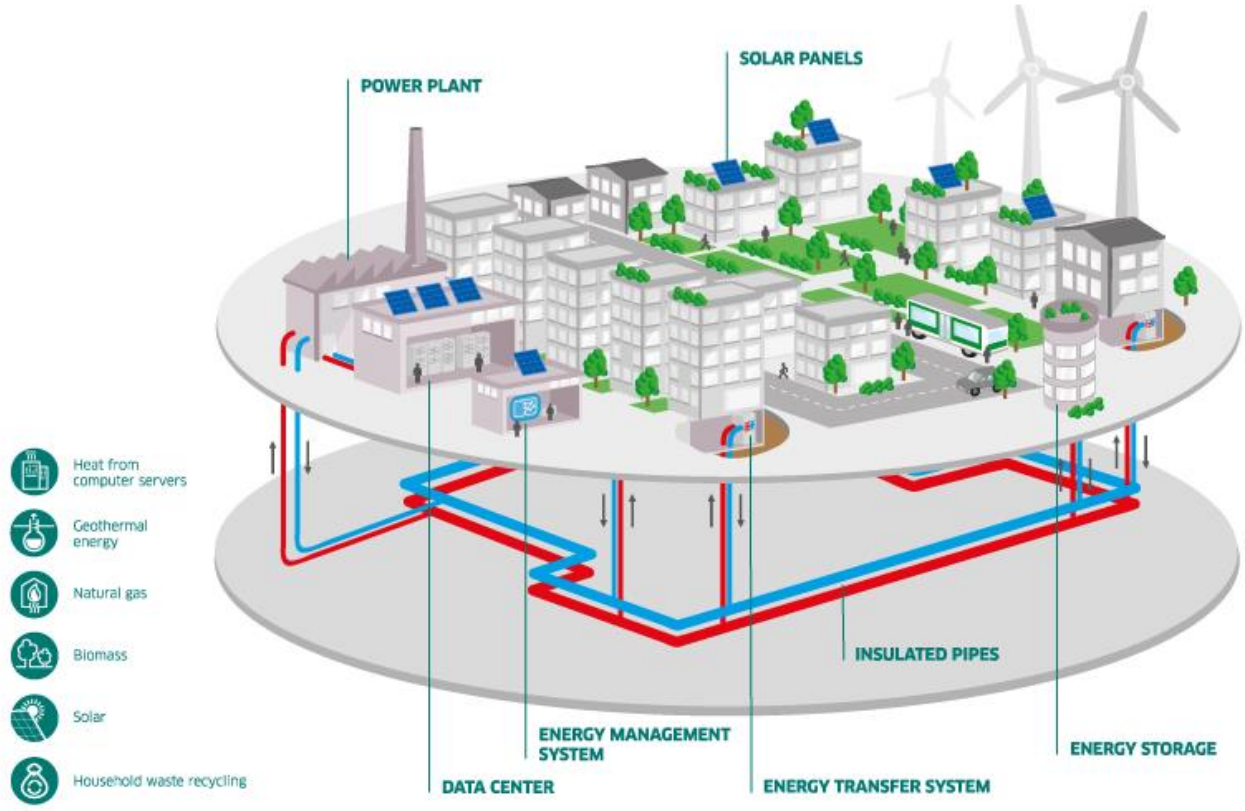
- Eliminate 1,542 tonnes of annual carbon emissions
- High-temp GSHP opex was similar to existing gas costs

- High-temp GSHP compared with electric boiler
  - Reduced energy use by > 64%
  - $4.5m additional capital investment
  - Simple payback of 4.1 years

- Promising result for considering 100% facility transition

Investment and Ownership

- A community-owned not-for-profit or cooperative business model.
- Public Owned Utility
- Hybrid Public and Private
- Private Owned Utility



District schemes = more savings, more sharing, more innovation, more collaboration, more progress….

Geoheat Potential of Future Development Zones

Potential Development Zones	Geothermal Characterisation					Regulatory Status	Geothermal Application Suitability Assessment					
				Depth Range Encountered[2]			Indirect Heating and Cooling			Direct Heating		
	Land Use Zoning	GNS Aquifer Potential[1]	Geology	>30°C	>50°C	Consent for Groundwater Take for Consumptive Use[3]	Closed Loop System	Open Loop System	District Heating and Cooling	Closed Loop System	Open Loop System	District Heating
Port of Tauranga	Industrial	Good	Sediments over volcanites	<125 m b.s.l	<500 m b.s.l	May not be available reinjection may be required	✓	o	✓	o	o	✓
Tauranga City Centre	Mixed Use Residential/Commercial	Good	Sediments over volcanites	<125 m b.s.l	<500 m b.s.l	Available	✓	✓	✓	✓	✓	✓
Te Papa Peninsula	Mixed Use Residential/Commercial	Good	Sediments over volcanites	<125 m b.s.l	<600 m b.s.l	Available	✓	✓	✓	✓	✓	✓
Tauriko	Residential	Good	Volcanites	<125 m b.s.l	<700 m b.s.l	Available	✓	✓	✓	✓	✓	✓
	Industrial						✓	✓	✓	o	✓	✓
Rangiuru Business Park	Industrial	Good	Sediments over volcanites	<75 m b.s.l	<200 m b.s.l	Available	✓	✓	✓	o	✓	✓
Eastern Centre	Residential	Good	Sediments over volcanites	<75 m b.s.l	<200 m b.s.l	Available	✓	✓	✓	o	✓	✓
Ōmokoroa / Te Puna	Residential	Good	Sediments over volcanites	<175 m b.s.l	<500 m b.s.l	Available	✓	✓	✓	✓	✓	✓
	Industrial						✓	✓	✓	o	✓	✓
Otūmoetai	Residential	Good	Sediments over volcanites	<75 m b.s.l	<450 m b.s.l	Available	✓	✓	✓	✓	✓	✓
Pāpāmoa East	Residential	Good	Sediments	<125 m b.s.l	>150 m b.s.l	Available	✓	✓	✓	✓	✓	✓
[1]Note: New Zealand Aquifer Potential Map Version 1.0, https://www.gns.cri.nz/data-and-resources/new-zealand-aquifer-potential-map-version-1-0/ [2]Note: high uncertainty due to the limited data available, especially when localising the areas with temperatures above 50 °C. [3]Note: BOPRC							✓	suitable	o	partly suitable		

Answering Questions

Could the western Bay of Plenty use its comparatively shallow low temperature geothermal resource to its strategic advantage as the region develops?

YES

AND

Importantly, how can this be done sustainably?

See the Action Items

Action Items

- Develop a Regional Vision and Strategy for Geoheat in terms of:
  - Decarbonisation;
  - Energy Security; and
  - Regional economic growth
- Investigate feasibility of geoheat applications:
  - Industry;
  - Pools;
  - Buildings – commercial and residential;
  - Horticulture; and
  - Future versions of Te Keteparaha Mo Nga Papakāinga Māori Housing Toolkit
- Consenting: Balancing supportive uptake and sustaining the resource; and
- Continue public education efforts on opportunities and benefits

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