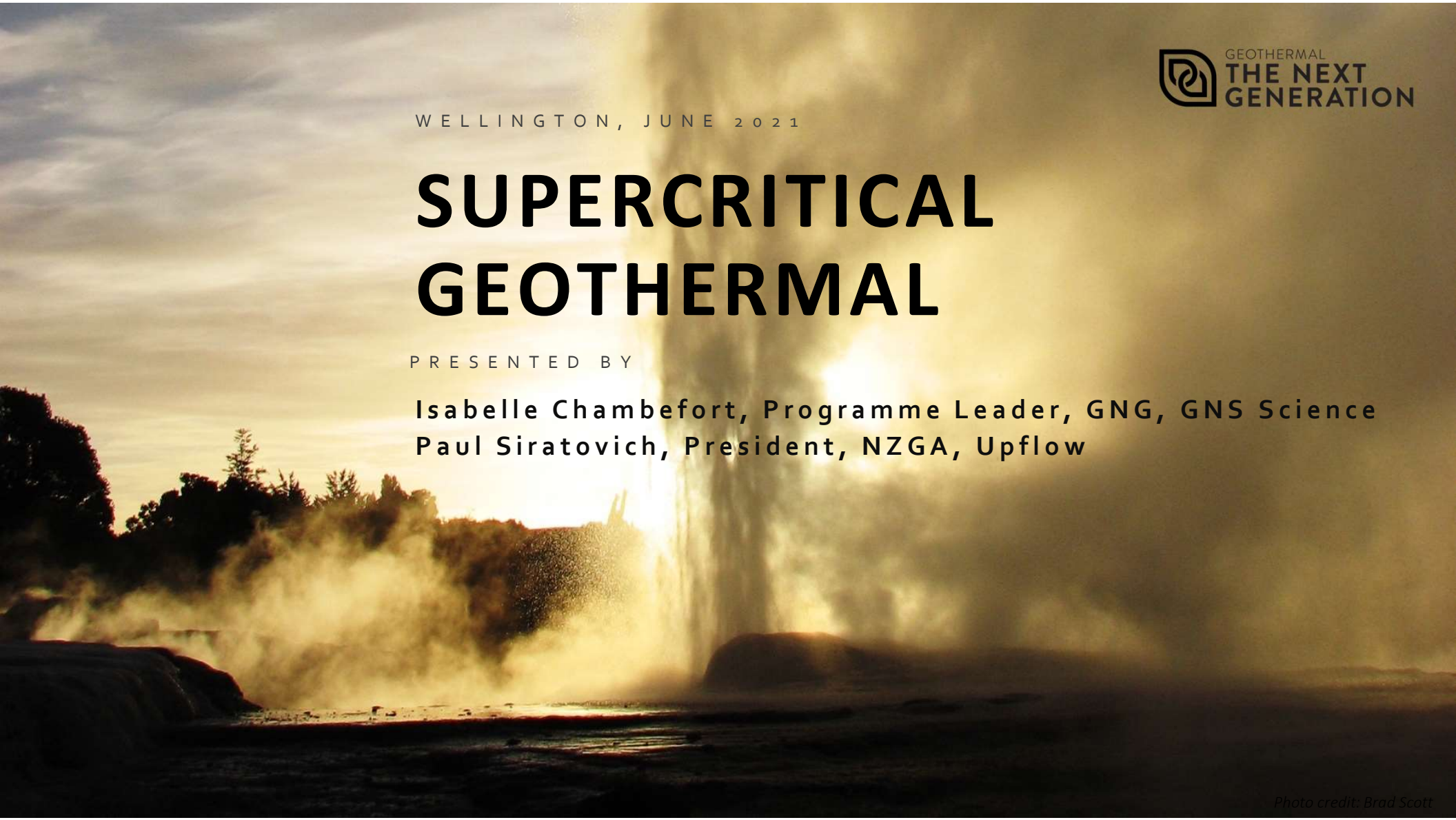
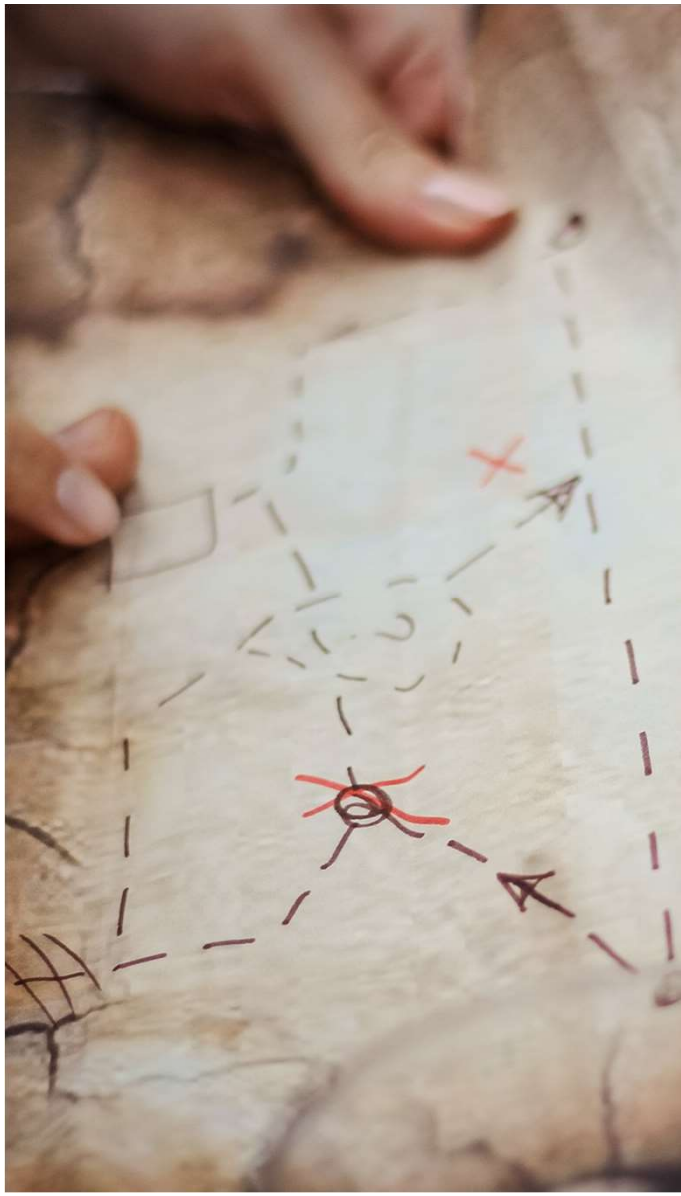

GEOTHERMAL
THE NEXT
GENERATION
WELLINGTON, JUNE 2021
SUPERCRITICAL
GEOTHERMAL
PRESENTED BY
Isabelle Chambefort, Programme Leader, GNG, GNS Science
Paul Siratovich, President, NZGA, Upflow
Photo credit: Brad Scott

Supercritical Geothermal

TODAY

Goal: introduction to supercritical geothermal energy

- Why geothermal energy for NZ?
- What is supercritical?
- A supercritical geothermal pathway to zero-carbon



Geothermal Advantage

WHY GEOTHERMAL?

- Abundant, low-carbon and cost-effective
- 17% of NZ's electricity (baseload supply)
- 21% of NZ's primary energy supplied
- High availability (90%-99%) – independent of weather
- 24/7 generation
- International innovation leadership

Geothermal Advantage

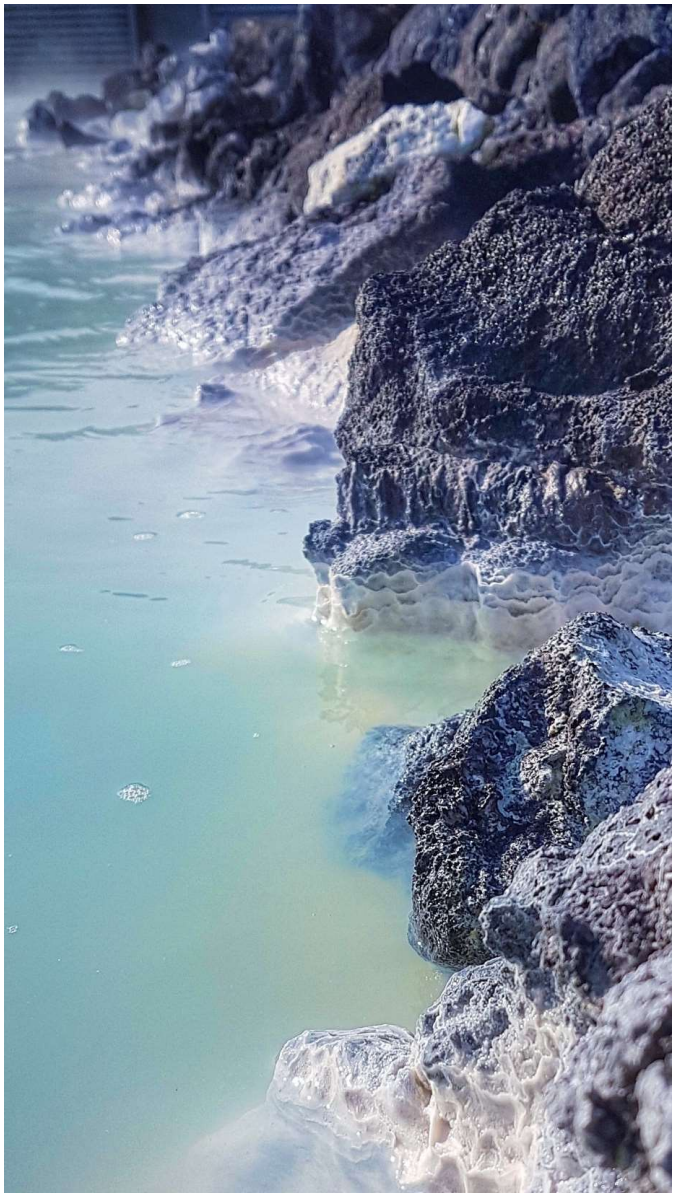
GEOTHERMAL ENABLES

- Supports strong and competitive business sectors
- Reduces production costs and improves environmental performance
- Access to strategic minerals and biotech solutions
- Regional economic growth
- Māori socio-economic development

Geothermal Advantage

ENVIRONMENTAL PERFORMANCE

- Geothermal has low CO_2 emissions during operation
- Life-cycle assessment (LCA) of emissions
- LCOE vs LCA
- Decarbonising industrial production of goods



Geothermal Advantage

STRATEGIC MINERALS

Taupō-based firm Geo40 secures investment in lithium extraction for EV batteries

Venture capital firm Pacific Channel invests $7.5 million to develop early stage technology to recover lithium from geothermal fluid.

A company hoping to mine geothermal waste for use in making electric vehicle batteries has received a cash injection to allow it to fast track its plans.

Geo40 has secured $7.5 million in equity investment from venture capital firm Pacific Channel to help it develop early stage technology to recover lithium from geothermal fluid.

What do you think? Click here to comment.

The company said it intended to supply the low carbon mineral to the electric vehicle battery market.

"Pacific Channel's investment now enables the company to accelerate its pilot plant plans and demonstrate that its recently developed lithium recovery method is capable of economically extracting lithium from geothermal and other subsurface fluids in an environmentally sustainable manner," chief executive and managing director John Worth said.

The company said global demand for lithium was forecast to increase in line with a rise in electric vehicle rise, as governments look to mandate their use.

Geothermal Advantage

REGIONAL PROSPERITY

	Activity	Size of operation	Geothermal Energy Used	Geothermal Field	FTE
Miraka	Milk processing facility	~300ML/year milk processed into milk powders and UHT	~2,400t/day clean steam from 2 pre-existing wells	Mokai	~120
Tenon	Timber Drying	150,000m3/year of timber dried	Geothermal heat plant with an installed capacity of 27 MW to heat 9 timber drying kilns. Consented take of 4110 tonnes/day of ~209°C fluid	Tauhara	265
Huka Prawn Park	Aquaculture tourism (Prawns)	~7.8 tonnes of prawns produced per year	450 tonnes/hour (~115°C) cascaded fluid from binary plant	Wairakei	60
Asaleo Care	Tissue & Toilet Paper Manufacturing	~50,000 tonnes/year of tissue product	254,510 GJ energy from geothermal steam (2016)	Kawerau	~200
Norske Skog	Paper production (Newsprint)	~150,000 tonnes/year paper production	3600 tonnes/day consented (~185°C). Including TA3 generator producing 9MW using 140t/hr steam	Kawerau	161

* FTEs = Full Time Equivalents. These numbers include all people working onsite at the operation, and excludes suppliers of steam and other contractors e.g. maintenance etc (Blair, 2018)

Geothermal Advantage

MĀORI OPPORTUNITIES

- Recognise and respect Te Tiriti o Waitangi
- Intergenerational prosperity and sustainability of natural resources
- Māori as kaitiaki, investors, landowners, partners
- Geothermal is long-term – the next generation will be the leaders and decision makers of the future
- Māori innovation is driving new approaches to geothermal development

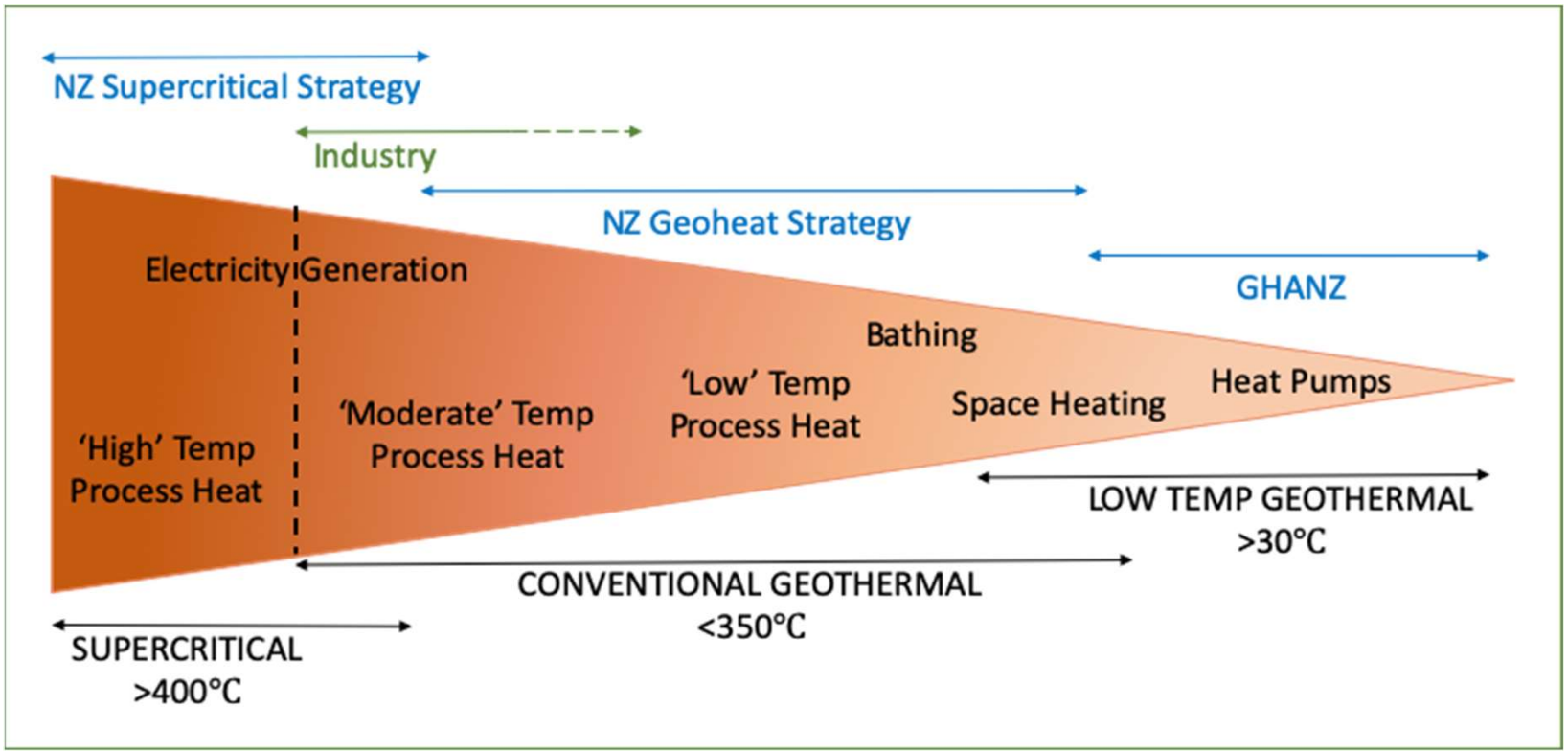
Geothermal Advantage

AOTEAROA'S GEOTHERMAL ENERGY FUTURE

- Decarbonising New Zealand's electricity and process heat sectors for over sixty years
- Competitive advantage in transitioning NZ energy sector and economy
- Key part of NZ's mixed renewable energy portfolio
- Enable other renewables & low-emission fuel production (e.g. biomass and green hydrogen)

N Z G e o t h e r m a l

LANDSCAPE



N Z G e o t h e r m a l

A RANGE OF APPLICATIONS

Supercritical resources will enable higher temperature industrial processes from geothermal, as well as more efficient electricity production

The highest temperature for process heat is 220°C (Miraka milk processing facility, Mokai)

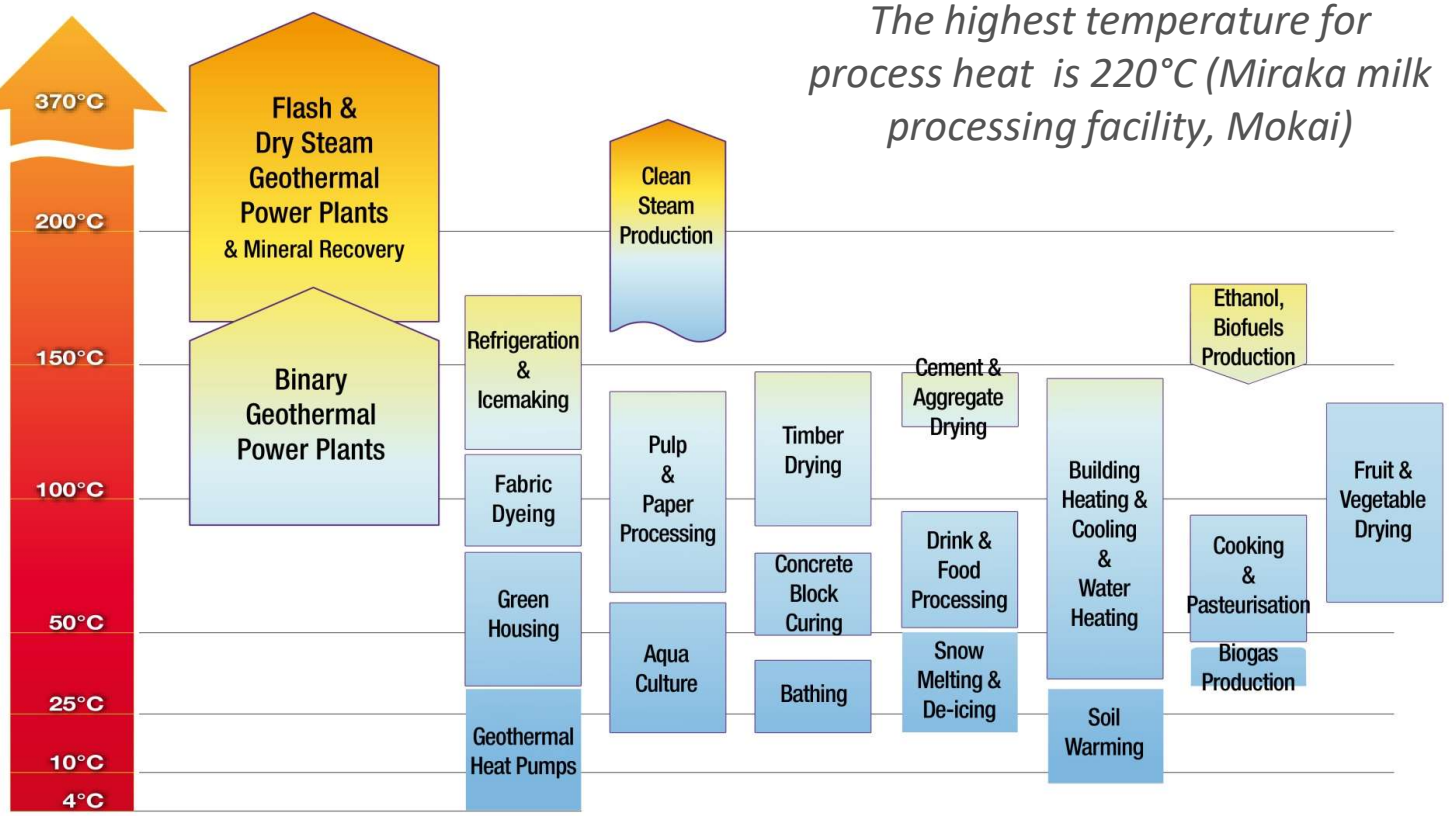
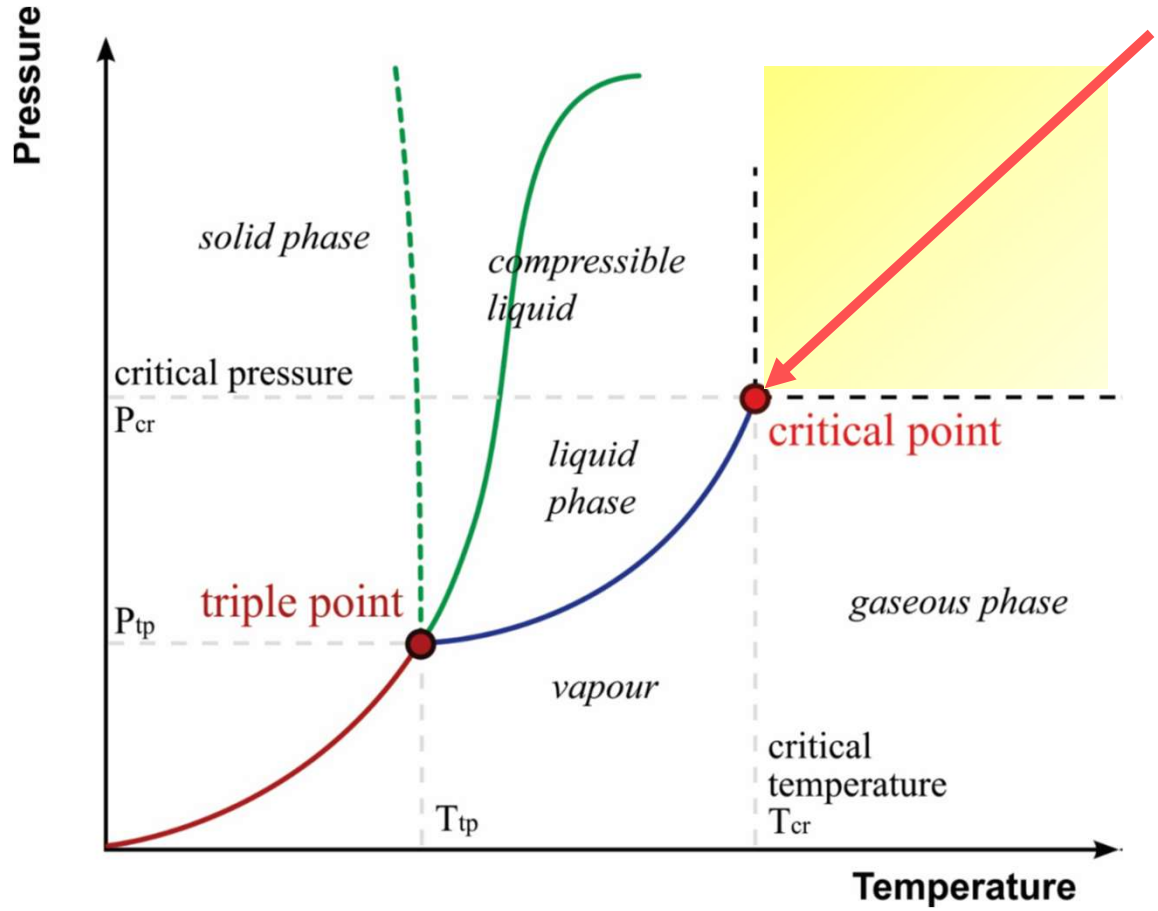


Image adapted from the Lindal Diagram (Lindal, 1973)

What is

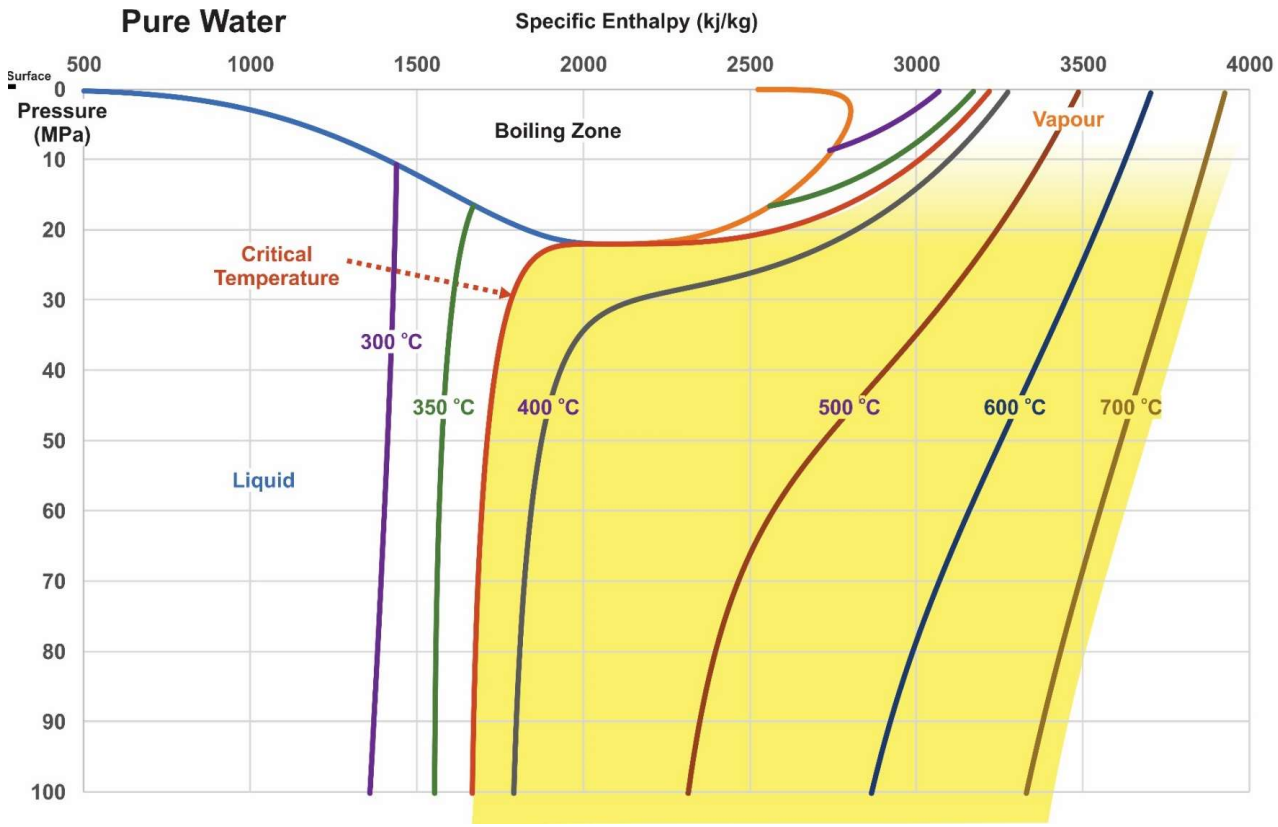
SUPERCRITICAL



Supercritical
Where for pure water :
temperature is >374°C
and pressure is >22MPa

Geothermal

SUPERCRITICAL



Supercritical could provide 10 times more energy than conventional geothermal

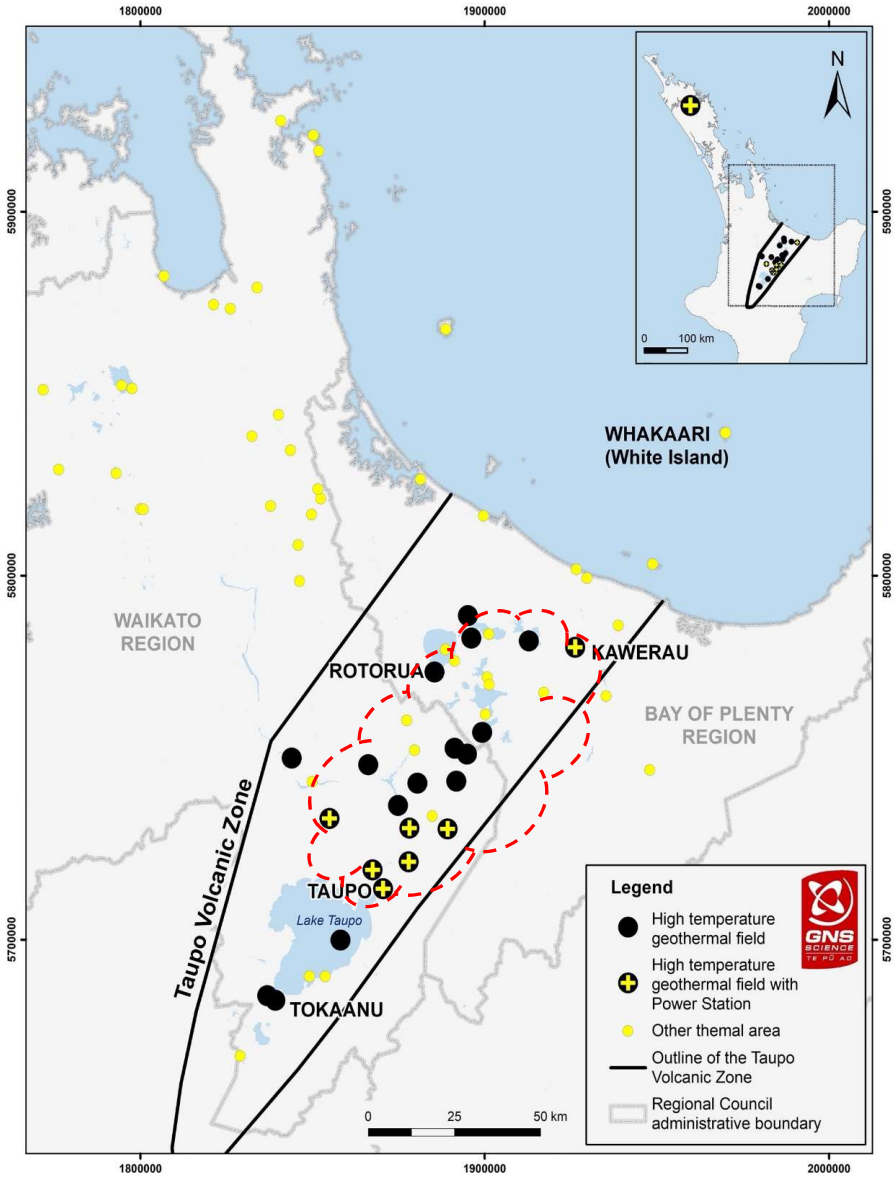
P, T(bar, °C)	Enthalpy (KJ/kg	Dynamic Viscosity (10^{-5} Pa.s) (KJ/kg	Ratio (Enthalpy/ viscosity)	Ratio to base case
100, 250	1086	10.0	108.8	1.0
100, 400	3100	2.45	1265	11.6
200, 400	2820	2.60	1085	10.0
300, 400	2162	4.34	498	4.6
400, 400	1934	6.13	315	2.9
500, 400	1878	6.79	277	2.5

Relative ease of extracting energy from a kg of fluid at 400°C. Yellow cells are conventional reservoir conditions. Green cells represent the targeted conditions (100 to 200 bars for 400°C) assuming similar permeability.

Supercritical

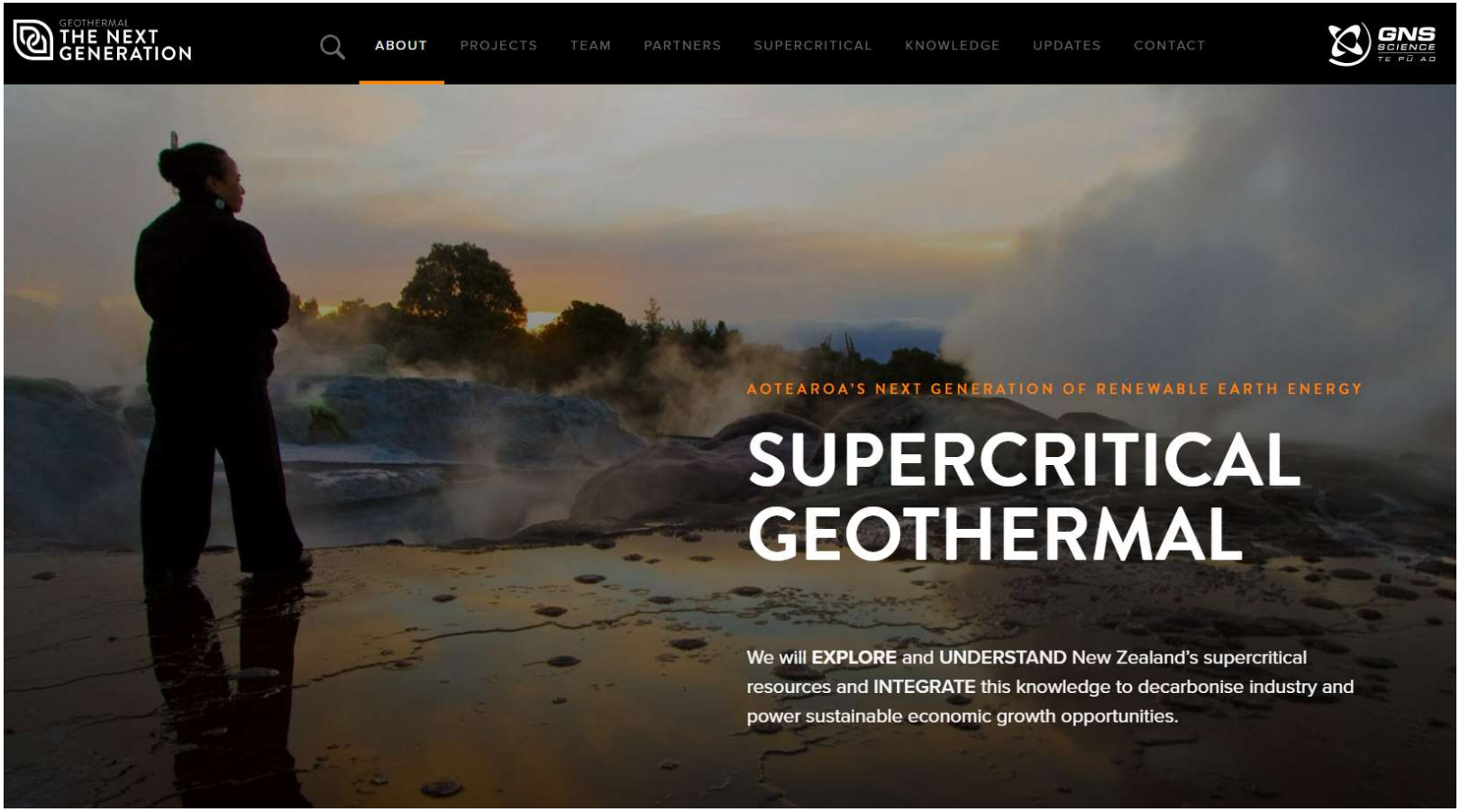
HOTTER & DEEPER

- Target → central area of Taupō Volcanic Zone (TVZ)
- Conventional (~3.5 km; <350°C)
- Supercritical (>5 km, >400°C)
- Expansion of geothermal operations & new resource developments



INTRO TO

GEOTHERMAL: THE NEXT GENERATION



WWW.GEOTHERMALNEXTGENERATION.COM

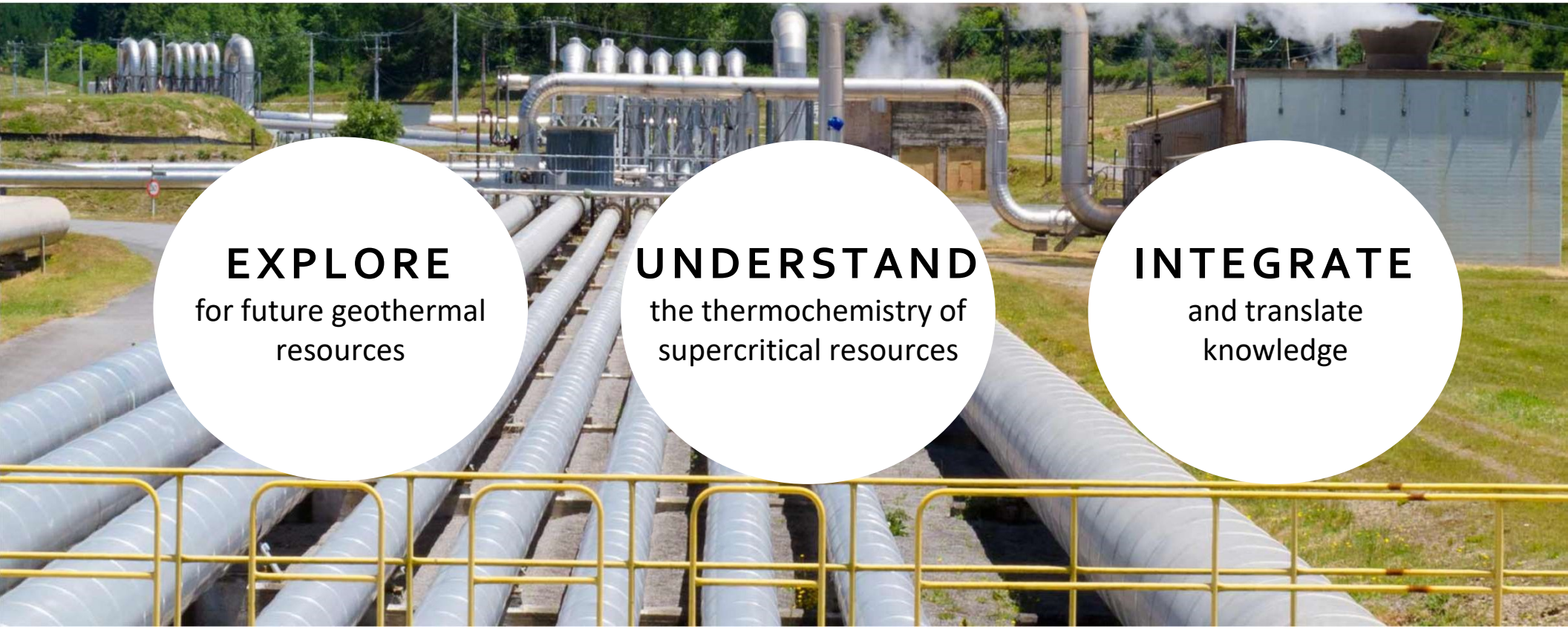
Supercritical

GEOTHERMAL THE NEXT GENERATION

- Five-year project (2019-2024)
- MBIE Endeavour Fund Research Programme
- Mission: to advance the **geoscientific understanding** of New Zealand's supercritical resources to de-risk exploration drilling
- Scope: to delineate Aotearoa's supercritical resources, and characterise their fundamentally-unique chemical and fluid dynamic properties

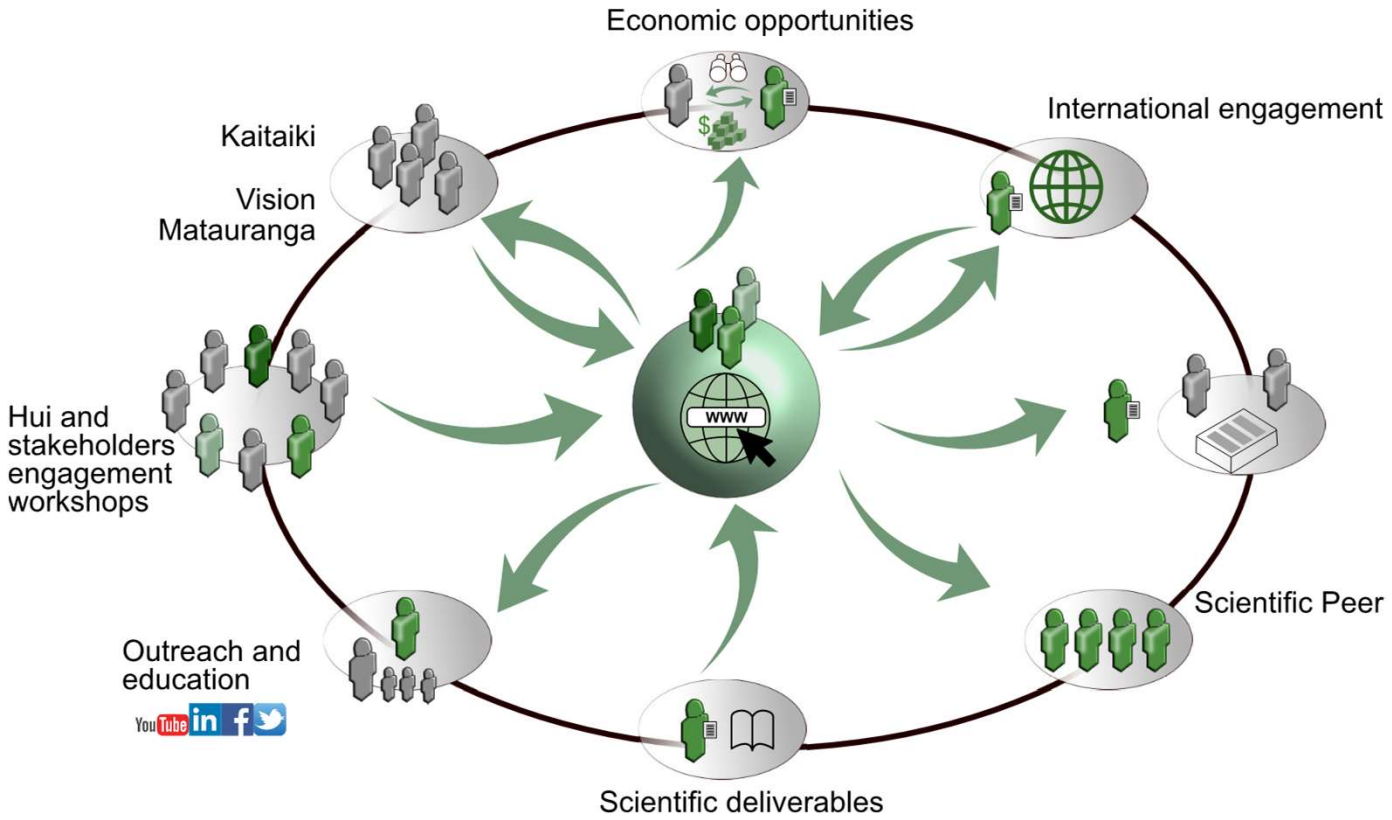
Supercritical

GNG PROJECTS



Integrate

AND TRANSLATE KNOWLEDGE



Supercritical Strategy

PATHWAY TO NZ'S SUPERCRITICAL FUTURE

- Supercritical is not guaranteed
- New understanding, technologies & best practice is needed
- A Supercritical Strategy for Aotearoa NZ (2020-2050): Aims to move NZ supercritical from an idea to business-as-usual

Supercritical Geothermal

INTERNATIONAL

- NZ has numerous research collaborations
- GNG International Advisory Board (Japan, Iceland, US)
- NZ leadership roles in international associations

  International Geothermal Association
  IEA Geothermal Implementing Agreement
  International Partnership for Geothermal Technology

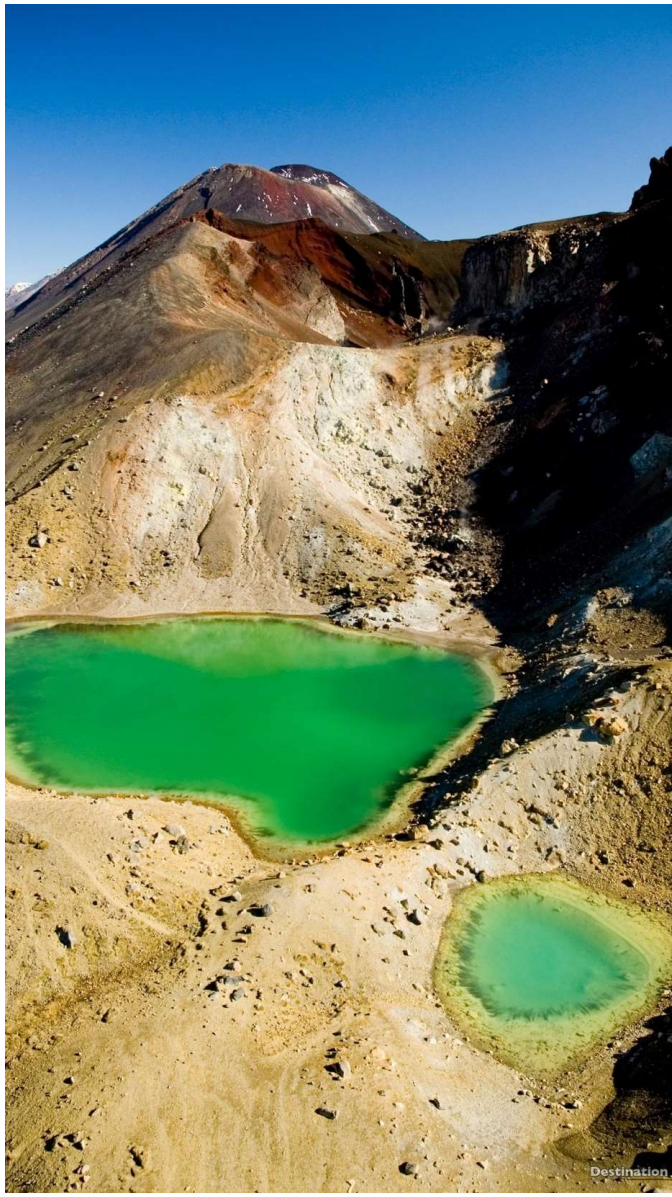
- Established international service industry; training & assistance programmes

Supercritical Strategy

FOUR BIG QUESTIONS

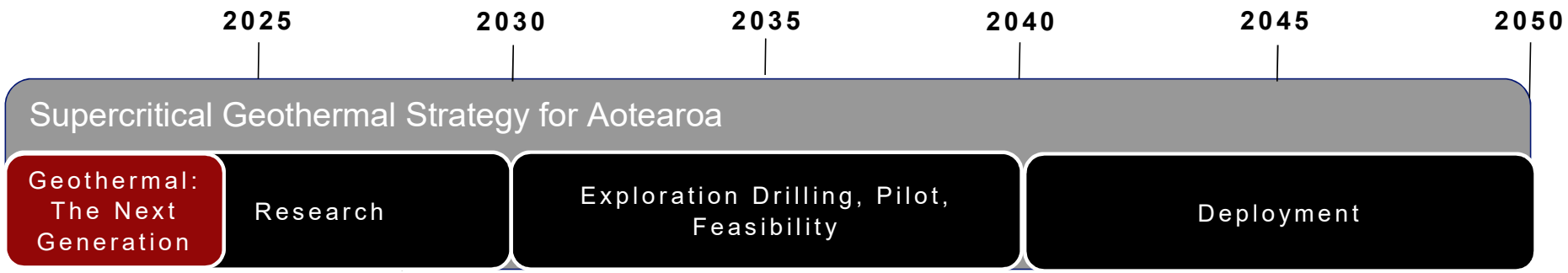
Our goal is for supercritical geothermal in NZ to be technically, financially, environmentally and socially viable.

1. How do we lead decarbonisation?
2. Where are the supercritical resources?
3. How do we drill into supercritical geothermal systems?
4. How do we use supercritical fluids?



Supercritical Strategy

FOR AOTEAROA NZ



- Aspirational – move along the technology readiness to deployable by 2040
- NZ a world leader in supercritical geothermal utilisation
- Co-design – using consultation with key groups, particularly Māori

CONNECT & LEARN MORE

- Websites & Social media (FB, LinkedIn)
  - www.geothermalnextgeneration.com
  - www.nzgeothermal.org.nz
- Participate in consultation for NZ Supercritical Strategy
- NZ Geothermal association seminar
  - 'Geothermal in a Low Carbon Future'
  - 29th July 2021, Taupō (during Geothermal Week)
- NZ Geothermal Workshop
  - 23rd-25th November2021, Te Papa, Wellington
- IPGT/IEA/GNG International Workshop
  - 'Supercritical Geothermal'
  - 30th Nov -2nd Dec, Wellington

GNG PARTNERS

KIA ORA

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Upflow

TE WHARE WANANGA O TE UPOKO O TE IKA A MAUI VICTORIA UNIVERSITY OF WELLINGTON

ETH Zürich

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

traverse ENVIRONMENTAL

BRIDGER CONSULTING

Presenters:
Paul Siratovich: paul.siratovich@upflow.nz
Isabelle Chambefort: i.chambefort@gns.cri.nz

Going Supercritical

WHAT INTERESTS YOU?

1. What questions do you have?
2. What do you need from us (to support your work)?
3. What do we need to know (about challenges and opportunities)?