An Overview of New Zealand's Geothermal Planning and Regulatory Framework

GEOTHERMAL: THE NEXT GENERATION

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Table of Contents

List of Figures

List of Tables

Report Information

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Author	Deborah Kissick, Traverse Environmental
Contributing Authors	Brian Carey, GNS Science, Melissa Climo, Bridger Consulting
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1 Introduction

The purpose of this report is to summarise the current planning and regulatory framework relating to the development and use of geothermal resources in New Zealand at the time the report was published. Our intent is to outline and highlight the frameworks that are, or could be, relevant to geothermal resources without forming judgement about the effectiveness of these frameworks.

This report has been prepared under the Geothermal: The Next Generation (GNG) research programme (Chambefort, et al., 2019). This background information will inform further research work under GNG, which will identify what is required for an effective and enabling planning framework, while achieving sustainable management. This will provide for geothermal development and the potential use of hotter, deeper supercritical geothermal resources.

During the drafting of this report, the NZ Government announced that it would repeal the Resource Management Act ("RMA"). The current recommendations are to replace the RMA with new legislation focussed on improving environmental outcomes and to better enable development within environmental limits. This reform provides an opportunity to contribute to and inform new legislation for geothermal resource management.

The chapters of this report will address:

- The background and history of geothermal resource use in New Zealand;
- The statutory framework that currently applies to the management and use of geothermal resources in New Zealand;
- How the statutory framework has been applied by Regional Councils in New Zealand where accessible high temperature geothermal resources may be present.

A glossary of terms and acronyms used in this report can be found in Appendix 1.

2 Geothermal: Earth Energy

This chapter provides a brief introduction to New Zealand's geothermal resources and their uses, an overview of the geothermal contribution to the nation's energy portfolio, and a brief summary of resource access and delineation.

Additional summary information on geothermal resources and their energy uses can be found in Appendix 2.

2.1 Geothermal Resources

Geothermal energy is heat from the Earth. In New Zealand, the Resource Management Act 1991 (RMA) classifies any water over 30°C heated through earth processes as geothermal fluid. Water below this temperature threshold is treated as freshwater under the RMA.

Surface expressions such as volcanoes, hot springs, geysers and fumaroles are all evidence of large heat sources beneath the ground. Faults, fractures and permeable formations act as channels, moving geothermal fluids and heat towards the surface of the earth. Across New Zealand, geothermal resources are observed at the land surface, and in some places under water in lakes, river beds, and also on the seabed.

New Zealand's geothermal activity predominantly occurs due to high heat flow in the crust along, and just off, the Pacific – Australian tectonic plate boundary. Hot springs occur in place along the length of New Zealand (Figure 2-1) from Ngāwhā in Northland to Fiordland at the bottom of the South Island. Geothermal activity also includes undersea expressions (located on the seafloor) in the Kermadec - Tonga arc, offshore in the broader Exclusive Economic Zone.

A geothermal resource is not an isolated entity. It forms part of a broader environment, linked to a deeper heat source, such as a magma body or radiogenic rock. The characteristics of a geothermal resource are influenced by:

- the climate of the region,
- the hydrology of water interacting with the subsurface heat source,
- whether the system is pressurised through submergence, and
- the dynamic earth processes occurring through time (e.g. earthquakes, eruptions).

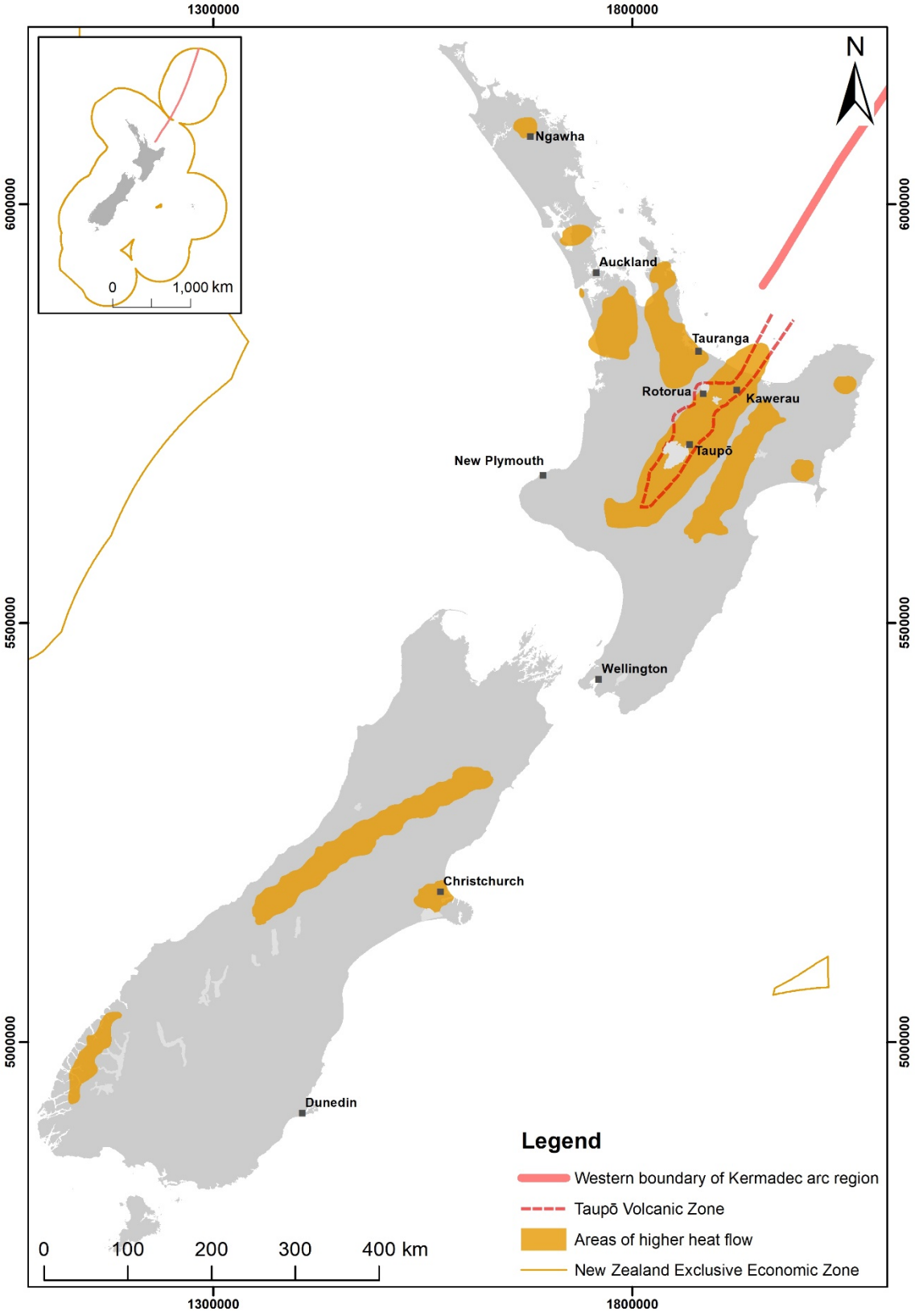

Figure 2-1 Areas of New Zealand where there is higher heat flow from depth to the ground surface and, in some places, geothermal surface expressions.

2.1.1 New Zealand's Geothermally Active Regions

The most well-recognised geothermal area in New Zealand is the Taupo Volcanic Zone (TVZ) (Figure 2-2), spanning some 100 km wide by 350 km long in the central North Island. This zone is abundant with geothermal activity and contains over twenty defined geothermal fields. Geothermal fields are areas with relatively high heat flow from depth to the surface, usually manifesting in surface features such as geysers, heated soils and hot springs. Off-shore, this geothermally active region extends to the north-east of the TVZ along the sea bed in the Kermadec-Tonga arc, with volcanism found in and near the arc. There is also a single high temperature geothermal field located in the Northland Region, at Ngāwhā (see Figure 2-3).

Table 2-1 Geothermal Fields in New Zealand's North Island (as shown on Figures 2-2 and 2-3)

1. Kawerau	10. Taheke	19. Waikite
2. Rotoma—Puhi Puhi	11. Tikitere—Ruahine	20. Waiotapu
3. Ohaaki—Broadlands	12. Rotoma—Tikorangi	21. Waimangu
4. Ngatamariki	13. Lake Rotokawa—Mokoia	22. Te Kopia
5. Horohoro	14. Atiamuri	23. Orakei Korako
6. Rotokawa	15. Rotorua	24. Tongariro
7. Mokai	16. Reporoa	25. Ngawha
8 Wairakei—Tauhara	17 Tauranga—Mount Maunganui	
9 Mangakino	18 Tokaanu—Waihi-Hipaua	

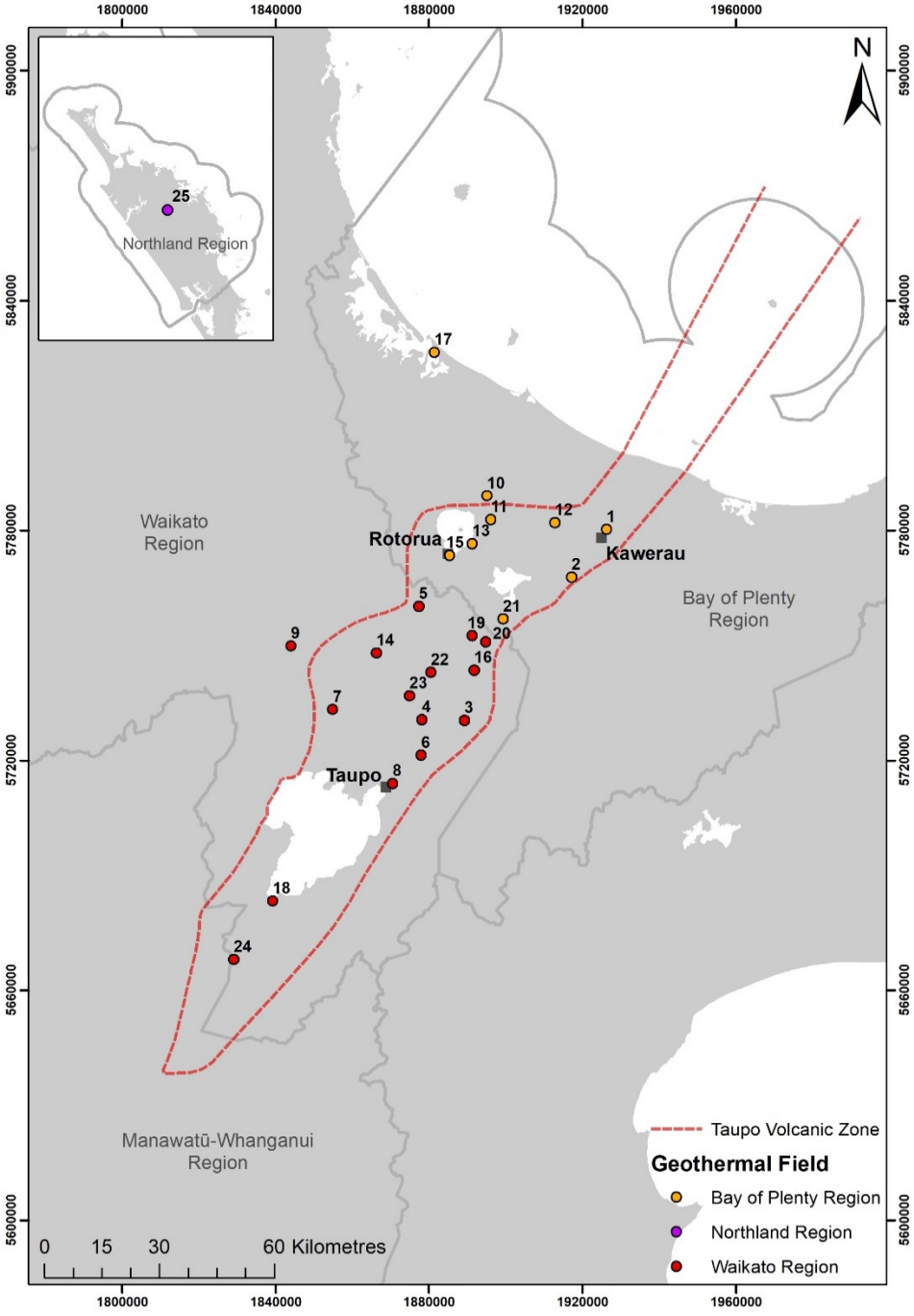

Figure 2-2: Geothermal Fields in the Taupo Volcanic Zone. Refer to Table 2-1 for the field names

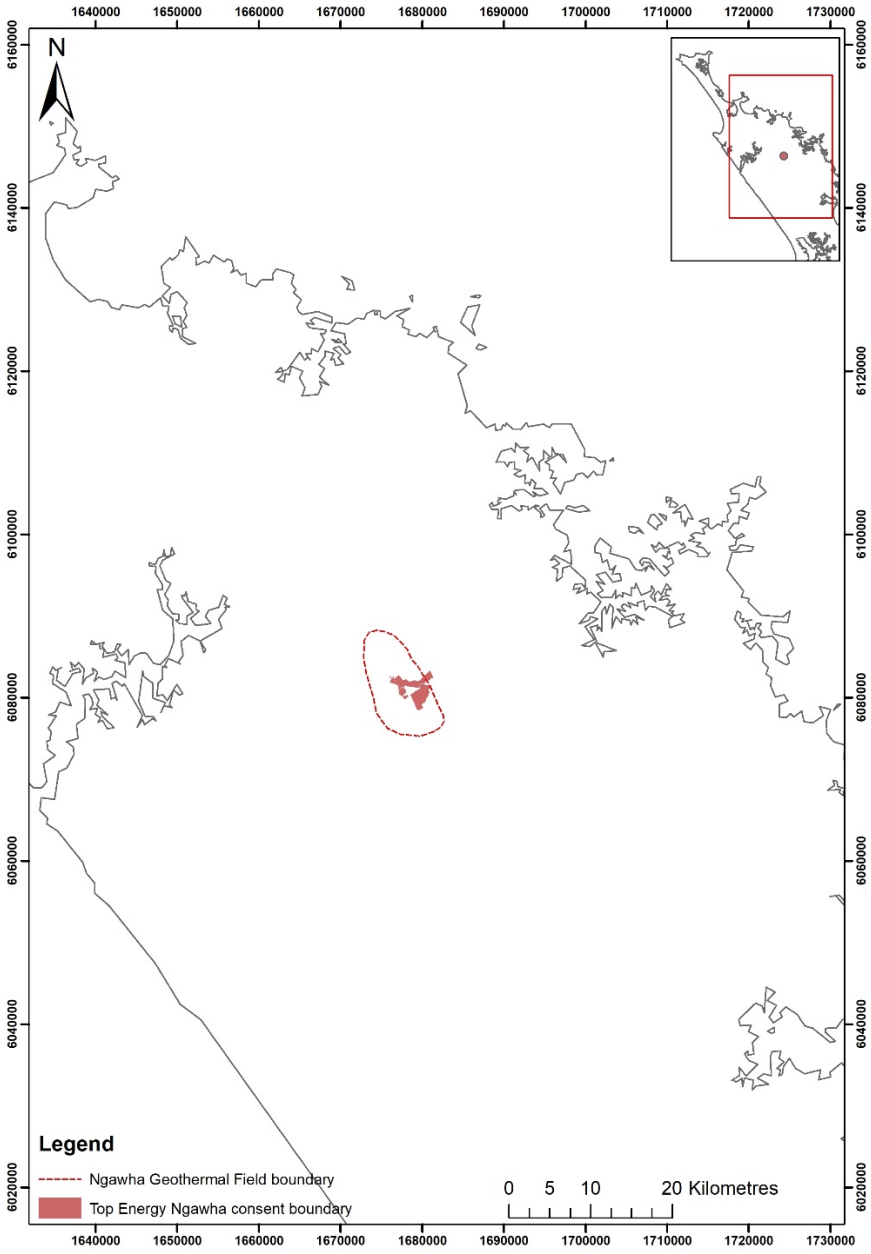

Figure 2-3 Ngāwhā

2.2 Geothermal Resource Use

A range of uses are possible depending on fluid temperature (see Table 2-2), from bathing at low temperatures, up to industrial processes and electricity generation at high temperatures. Geothermal fluids can also be used for their mineral content, either in tourist ventures or minerals production processes.

This chapter provides a brief summary of geothermal resource utilisation applications under four broad categories:

- Electricity Production
- Direct Use
- Tourism
- Geothermal Products
    - Minerals
    - Microbes

2.2.1 A Brief History

Māori made use of geothermal resources in support of community life for activities, including heating (facility, seed raising and gardening beds); cooking and food preparation; bathing; recuperative, healing, its medicinal qualities; and as a source of certain minerals (sulphur) and dyes (kokowai).

In the nineteenth and early twentieth-century, post-European settlement, the New Zealand government principally saw geothermal surface features as valuable for their tourism value; for visiting the sights, bathing, and balneology (Boast, 1992; Rockel, 1986).

Energy use from geothermal resources first started to be discussed around 1920 (Bolton, 1998). Well drilling for direct use commenced in Rotorua in the 1930's (RDC, 2018), investigations for geothermal electricity generation commenced in the late 1940's (Bolton, 1998) and interest in industrial use for paper production in the 1950's (Carter and Hotson, 1992). Electricity generation from geothermal resources began in 1958, and investigation toward commercial production of minerals from geothermal started to be discussed in the early 1960's (Climo et al., 2020). More recently, there has been interest in the biotechnology potential from microorganisms living in geothermal environments.

New Zealand's knowledge of its deeper geothermal resources has grown substantially from the 1940's as drilling deeper into the underground has occurred. Our understanding is currently constrained by the state of the technology able to access, detect, map, and monitor the geothermal resources, along with our ability to interpret what is known about the physically separate but linked parts that make up a geothermal system.

2.2.2 Electricity Production

Geothermal is low-carbon renewable energy that New Zealand has been able to harness reliably as base load energy[1] (>95% availability).

The first generator at the Wairakei Geothermal Power Station produced electricity to the national grid in 1958, with all the turbine generator units operational by the end of 1963.

[1] Being energy that is less susceptible to external influence due to the consistency of supply, unlike wind energy for example, which is more variable with time.

In 2019, 17.4% of New Zealand's electricity generation came from geothermal power stations (refer Figure 2-4).

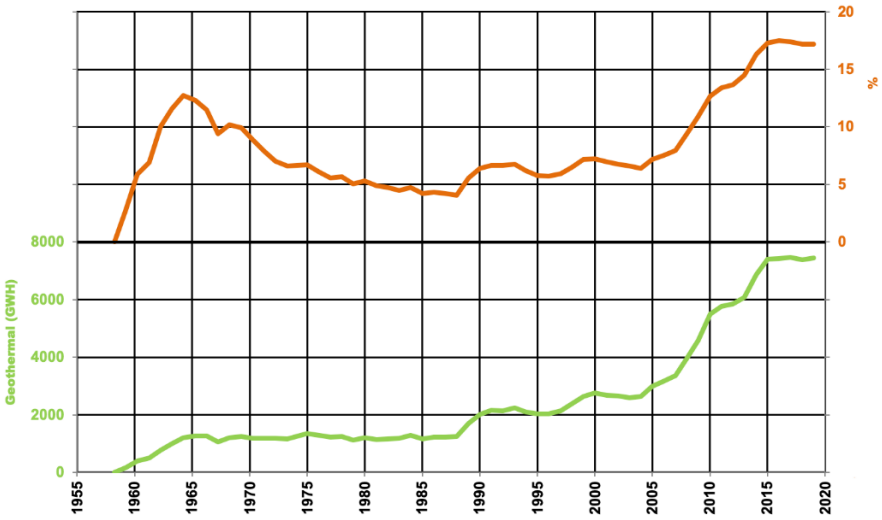

Figure 2-4 Geothermal generation GWH per annum (left axis; green) and geothermal percentage of total electricity generated in New Zealand (right axis; orange).

A number of geothermal fields in the Taupō Volcanic Zone (Figure 2-2) and at Ngāwhā (Figure 2-3) are used to generate electricity. The deregulation of the electricity sector that commenced in 1987 has seen State Owned Enterprises, public companies, consumer trusts and Māori entities now involved in developing geothermal power generation facilities, with growth over time occurring particularly after 2005.

Two technologies for electricity generation are in use in New Zealand:

1. Geothermal Steam: steam produced from two phase geothermal fluids or produced directly from the underground is supplied to steam turbine driven generators, and
2. Binary Cycle: heat transfer from geothermal fluids to a secondary fluid, usually an organic fluid such as N-pentane or iso-pentane. The pentane fluids are in a closed loop. These fluids accept heat from the geothermal fluids, drive the turbines, release heat to the atmosphere and then are pumped back up to be reheated again in the loop.

2.2.3 Direct Use

A number of sectors (tourism, aquaculture, agriculture, industrial, commercial, and residential) directly utilise geothermal heat in a range of applications, including timber drying, pulp and paper processing, milk processing, aquaculture, flower growing, vegetable growing, bathing, therapeutic, medicinal uses, minerals (silica), space heating and cooling, and water heating.

Bathing is the oldest direct use of geothermal resources in New Zealand with early Māori use dating back more than 800 years. Industrial geothermal energy use was first discussed in 1918 (Bolton, 1998), and direct heat use using extracted well fluids commenced in Rotorua in the 1930s. Exploration well drilling commenced at Kawerau in 1956 with the drilling of six 300m deep wells (Carter and Hotson, 1992). Success lead to geothermal being adopted and geothermal heat use commencing at Kawerau in 1959 (Carter and Hotson, 1992).

The Kawerau site is the largest direct geothermal energy use site in the world. In 2018, some 6.2 PJ of energy was supplied to these facilities (Daysh et al., 2020). Bathing, the oldest use, today remains the largest use in terms of total number of operations.

Evident are periods of growth, little or no change, and at times decline; influenced by market economics (national and international), company strategies and at times government intervention (Climo et al., 2016; MBIE, 2018).

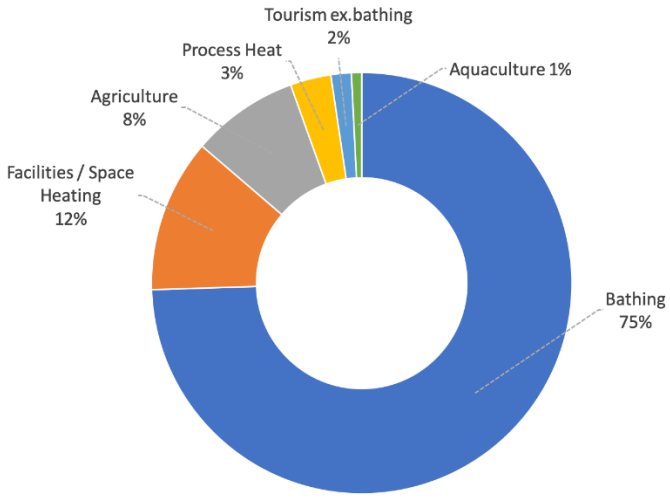

Figure 2-5 Percentage geothermal direct users by category (excluding residential) from the GNS Geothermal Database, with updated data for Process Heat Users (amendments made 2020).

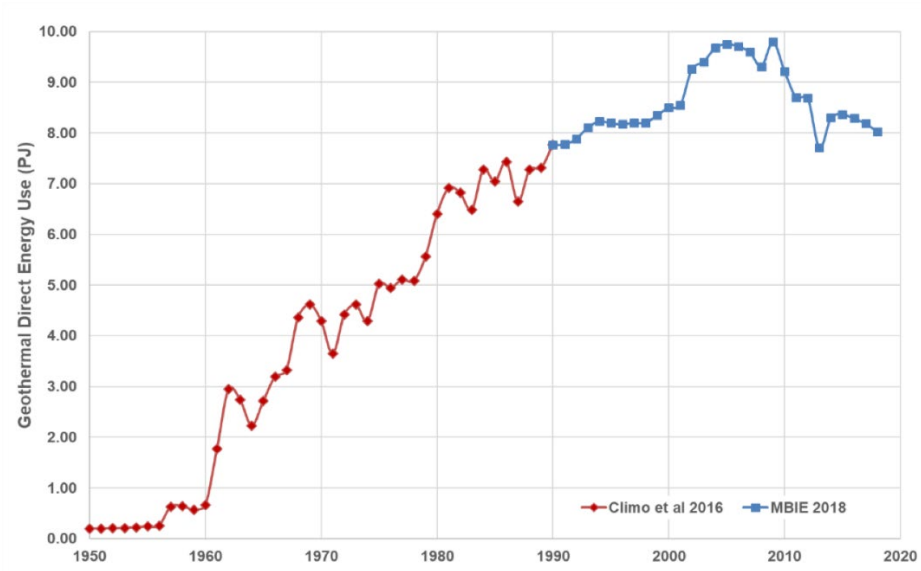

Figure 2-6 Estimated annual energy use (PJ) in direct geothermal applications since the 1950s (red and blue).

Processes which use heat energy in the low and medium temperature categories (Table 2-2, MBIE 2019a) can successfully use geothermal energy directly. The highest temperature for an operating geothermal heat supply is at Kawerau, where geothermal steam is supplied to a reboiler at an operating temperature of ~220°C producing process steam for tissue manufacturing and milk processing at 205°C.

Table 2-2 Process heat use temperature categorisation (from MBIE, 2019a)

Category	Process Temperature	Use
Low	Less than 100°C	Water heating, Space heating, Sanitisation of equipment in the food processing sector
Medium	Between 100 and 300°C	Industrial processes, Drying wood products, Drying food products. The highest temperature in food processing is around 200°C for drying milk powder
High	Greater than 300°C	Industrial processes, Oil refining, Melting metals, Chemical manufacturing

There are significant opportunities for New Zealand to use more geothermal energy directly as the nation transitions to "zero carbon" energy by 2050; the target set by the Climate Change Response (Zero Carbon) Amendment Act 2019.

The New Zealand Geothermal Association Geoheat Strategy for Aotearoa NZ, 2017-2030 (Climo et al., 2017a) seeks to assist New Zealand to move some of its energy use to lower carbon geothermal energy sources.

Examples of other nations generating products using geothermal energy and materials include ENEL Green Power at Chiusdino Italy (Richter, 2018), and Spain (at a geothermal site Tenerife (Spiterm, 2020) where they are growing Spiralina using geothermal heat and CO_2 and ORF Genetics (Sudurnes, Iceland, (ORF, 2020)) growing genetically engineered barley for use in medical, drug discovery and cosmetics research. Opportunities await New Zealand in this space.

Additionally, New Zealand has an opportunity, in future, to access 'high' process temperatures (refer Table 2-2) for industrial processes that reside in the high temperature categories. These industrial processes cannot use geothermal resources because the temperatures obtainable on the surface are not sufficiently high. The supercritical geothermal resources being considered as part of the GNG research programme (Chambefort et al., 2019) are expected to be at temperatures in excess of ~400°C, possibly as hot as 600°C, at 4-7 km depth. When extracted, these fluids will result in somewhat lower temperatures being available for use at the surface, albeit still expected to deliver 350°C to 400°C fluids for use.

2.2.4 Tourism

Tourism is arguably New Zealand's oldest geothermal business venture, attracting both domestic and international visitors. Unique volcanic and geothermal environments provide a combination of nature-based, ecological, cultural, historical, wellness/health, geological heritage, industrial and extreme (adventure) tourism experiences (Climo et al., 2017b).

New Zealand's geothermal tourism focus to date has been in three key areas: (i) spas and bathing; (ii) outdoor environments; and (iii) cultural experiences. Geothermal tourist parks in New Zealand offer an opportunity for visitors to explore natural geothermal environments.

The Rotorua region was known in the 18th century for the curative powers of the hot pools, visited by Māori from other parts of New Zealand. International interest in New Zealand's geothermal sites, particularly the pink and white terraces, commenced in the early 1800s to the Rotorua region and continues today (Neilson et al., 2010).

Spa attractions were developed in late 1800s in the Central North Island (Rotorua, Taupo, Tokaanu, Wairakei) for hot springs, bathing and balneology, as well as in other parts of the country, including Waiwera (near Auckland), Te Aroha, Hanmer Springs and later at Hot Water Beach at Hahei in the Coromandel.

A strength of the Central North Island sites is the combination of Māori culture and the geothermal experience, at places such as Whakarewarewa Village and Te Puia.

Geothermal tourism continues to be an important element in New Zealand's tourism offering (Tourism NZ, 2020).

2.2.5 Geothermal Products

Geothermal resources and environments offer opportunity beyond heat and energy, in the form of materials and products such as minerals, microbiology and other products.

2.2.5.1 Minerals

Below ground, geothermal fluids are heated as they travel through rock bodies. They interact with the rocks and become increasingly saturated with various minerals and metals, some of which could be processed into saleable products.

Solids Mining

Geothermal and volcanic activity can alter rocks, concentrating minerals of industrial interest, such as hallosite (clay), zeolite, perlite and native sulphur.

Māori traditionally mined materials at various geothermal sites, with examples including kokowai, a dye, collected at Wairakei (Stokes, 2000) and sulphur from Rotokawa, dug out in "big blocks" and "carried off in sacks and pikau bags" to be used for medicinal purposes (Whata, 1979).

Ventures to commercially mine sulphur at Whakaari (White Island) and cinnabar (an ore of mercury) at Ngāwhā started in the 1870s. The twentieth century saw repeated attempts to create profitable ventures at both sites, and a third endeavour mining sulphur at Rotokawa, though none were particularly successful.

Today, several mineral companies extract geothermally produced minerals including:

- halloysite clay from Matauri Bay, Northland mined by Imerys Ceramics New Zealand Limited,
- zeolite from Ngakuru by Blue Pacific Minerals, and
- perlite from south of Tokoroa also by Blue Pacific Minerals.

Solution Mining

The composition and volume of hot geothermal fluids (including steam) offer a source of dissolved elements and minerals. New Zealand fluids contain elements such as silica, lithium and boron, as well as gold and silver, carbonates and sulphates. Additional saleable products could also include sulphuric acid and carbon dioxide.

Solution mining from geothermal fluids was first studied in the late 1950's (Kennedy, 1957), and various silica pilot plant trials occurred from the 1970's. Lithium extraction investigations occurred in the 1980s and 1990s (Brown and Bacon, 2009), but the only commercial-scale operation in New Zealand, Geo40,

started mining silica from geothermal fluids in 2018 (GRC, 2018) at the Ohaaki geothermal field. Methods are currently being tested alongside this silica operation to extract lithium and other metals.

2.2.5.2 Microbiology

Geothermal environments are home to extremophilic microorganisms, a generic term used to describe microorganisms that thrive in conditions that can include temperatures as high as 121°C, pH ranges from 0.5-11, high levels of radiation, salts and/or heavy metals. The microorganisms have developed novel mechanisms to survive in these conditions, and these rare metabolisms and capabilities represent significant opportunities for biotechnological applications and improvement of existing industrial processes.

Interest in biotechnology potential increased from the 1970's through work undertaken by researchers at the University of Waikato. GNS Science commenced an extremophiles research programme in 2002 (GNS, 2002), including the comprehensive 1000 springs project database partnered with the University of Waikato (Stott, 2012). In 2018, GNS Science ended their microbiology research and the University of Canterbury has since become active in extremophile research in geothermal environments.

2.3 Geothermal Contribution to NZ's Energy Portfolio

Appendix 3 contains an overview of New Zealand's Energy Use and Greenhouse Gas Emissions, including primary energy sources, consumed energy, electricity generation and greenhouse gas emissions by energy source and type.

Overall geothermal energy is a significant contributor to New Zealand's energy supply, with the most recently available summary figures from MBIE as follows:

- Geothermal supplies 21.7% of New Zealand's primary energy[2] (2019)
- Geothermal energy supplies 17.4% of New Zealand's generated electricity (2019)
- Geothermal sources account for 5.7% of consumed energy (2019)
- Geothermal accounts for 2.3% of greenhouse gas energy production and use emissions (2018)
- Geothermal electricity accounts for a median life-cycle emissions intensity of 70% gCO2e/kwh (2021)

In future, renewable energy resources will be an increasing component of New Zealand's 2050 "zero carbon" energy portfolio, but the nation has quite some distance to go to achieve this target, with all carbon-friendly energy sources needing to significantly increase their contribution.

2 Primary energy supply is the amount of energy available for use in New Zealand accounting for imports and exports. MBIE (2019)

The challenge for the geothermal sector is to sustainably use geothermal systems to the fullest possible extent, *and* to go beyond conventional resources, tapping into deeper supercritical heat resources - expected to offer substantial additional energy potential.

Appendix 4 contains a comparative life cycle assessment of greenhouse gases emissions from New Zealand's geothermal electricity generation facilities compared to other generation types reported in the international literature.

2.4 Resource Delineation & Access

2.4.1 Resource Ownership

New Zealand common law doesn't assign ownership of movable resources, such as geothermal fluid, until it is captured (White et al, 1995). Like other natural unappropriated waters, the underground water itself in situ is not the subject of property; it is not an object of ownership (Barton, 2015). While geothermal resources are not owned, the discharged fluid can be.

The Geothermal Energy Act 1953 created the resource ownership approach still in use today – management of geothermal energy is vested in the Crown (i.e. New Zealand Government) and the Geothermal Energy Act gave the Crown the sole right to "take, tap, use and apply" geothermal energy. This treatment is more similar to that of natural water than petroleum and most minerals, whose ownership is specifically vested in the Crown. Geothermal fluid and associated energy are essentially treated as water in terms of legislation.

Geothermal resources are considered to be a component of the land, but the current resource management approach means that landowners do not automatically have rights to develop geothermal resources that lie below their land. Land ownership in New Zealand gives rights to what lies on the surface, below the ground and in the air column above the ground – but no ownership per se of the air above nor underground water resources. Likewise, no royalty rights are conferred. Section 5.1.1 below explores the use of geothermal resources under the Resource Management Act, including the specific provision made for use of geothermal resources in accordance with tikanga Māori *"for the communal benefit of the tangata whenua of the area and does not have an adverse effect on the environment"*.

Aspects of the ownership of geothermal resources have been raised through a number of Treaty of Waitangi claims with Tribunal recommendations made to the government, settlements worked through between claimants and the government, and ultimately Claims Settlement Acts being enacted. Geothermal resource ownership is not conferred through existing Acts or Statutory Acknowledgements.

2.4.2 Access

The legislation requires permits (i.e. resource consents) for access to, and use of, geothermal resources, and this requirement applies equally to landowners and developers who do not own the land overlying a resource.

Permission from the landowner is required to access geothermal resources beneath their land. The landowner can defend his or her rights against an unauthorized intrusion (i.e. trespass). There is no depth at which an intrusion ceases to be trespass, including through the use of directional drilling. There is no rule that restricts the depth to which the owner of land can assert his or her rights to the land (Barton, 2015).

2.4.3 Defining a Geothermal Resource

To develop an understanding of geothermal systems and assess their energy potential, sophisticated scientific techniques are required to "see" beneath the subsurface. Geoscientific methods include field assessment, geological mapping and structural mapping, together with documenting the distribution and type of geothermal surface expressions and features. Geochemical surveying, sampling, and evaluation of the geothermal manifestations provides insight into the underground conditions that might be encountered.

Geophysical methods investigate the processes and properties of the subsurface. Maps, interpretations and models (e.g. Figure 2-7) are developed from these data sets. Three-dimensional geological models (static) use well data to further assist visualisation of the underground. Reservoir models and simulations provide information on the energy that might usefully be extracted from the reservoir, the effects that might be experienced in the reservoir, and by the surrounding environment (at depth, in the shallow subsurface and at the surface).

The current regulatory framework for geothermal resources requires the field 'boundary' to be identified and delineated. The field boundaries are assessed, including using a combination of geoscientific and well information. In planning documents, these boundaries are plotted in plan view (i.e. projected on a horizontal plane). However, the underground reality of geothermal resources (e.g. Figure 2-7) is that the geothermal reservoir and field boundaries are three dimensional and also gradational – they have a boundary zone moving from "inside" to "outside" (and not a defined line, like a wall).

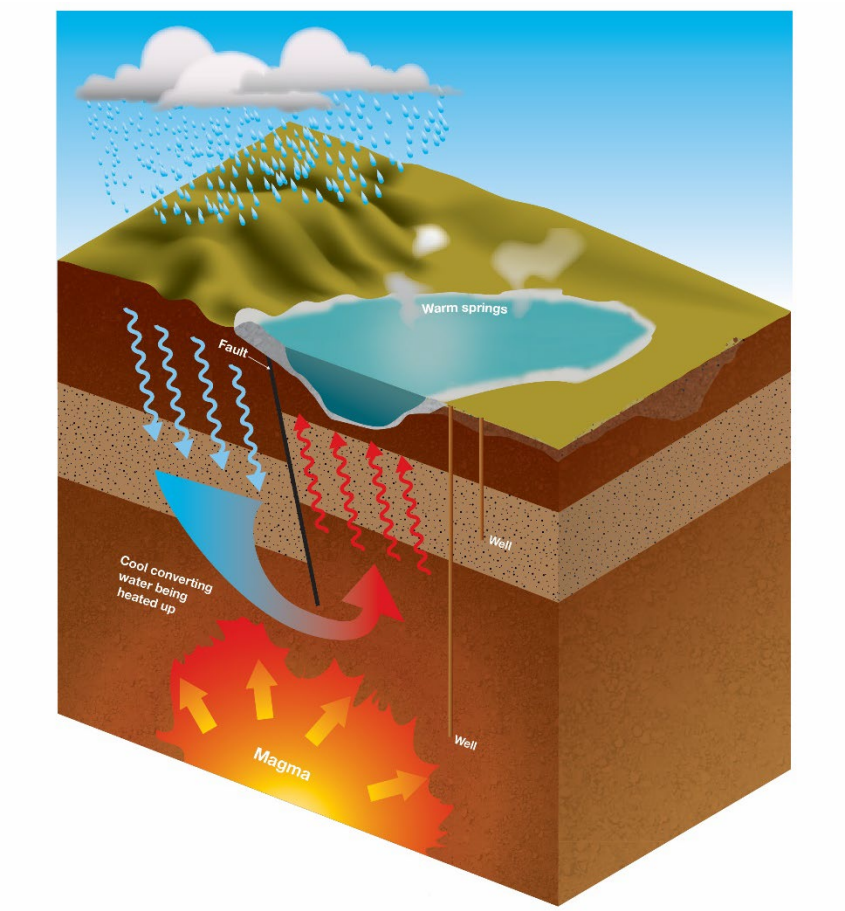

Figure 2-7 Conceptual diagram of a geothermal system showing generic relationships between underground and surface expressions with water moving the heat from underground to the surface. Diagram shows wells tapping into the resource to produce energy for use at the surface.

Drilling technology has developed since the late 1940's and has greatly enhanced our understanding of New Zealand's geothermal resources. Original geothermal drilling used rigs designed to drill wells for shallow geotechnical investigations or prospecting for mineral resources. Through time, drilling depth has increased, and in New Zealand today, geothermal wells are routinely drilled to 3500m. The results obtained from deeper wells and well testing further illuminates our understanding of the geothermal resources.

There will always be more to learn about geothermal resources – deeper wells will continue to reveal new knowledge and advances in computational capacity open up new modelling possibilities refining our ideas and augmenting our understanding.

3 Statutory Overview

This chapter provides a brief overview of the current statutory framework that applies to the management and use of geothermal resources in New Zealand.

Chapters 5-7 of this report provide a more detailed review of this framework.

This report will not cover aspects of geothermal resource use related to the Building Act or health and safety requirements.

For ease of reference we have grouped legislation under the Resource Management Act (Chapter 5), other resource management legislation (Chapter 6) and energy, conservation and mineral legislation (Chapter 7). The Acts can be accessed in full at www.legislation.govt.nz

3.1 Overview: Resource Management

New Zealand has four primary Acts that comprise resource management legislation relevant to geothermal resources:

1. Resource Management Act 1991 (the current reform process is discussed in Section 4)
2. Marine and Coastal Area (Takutai Moana) Act 2011
3. Conservation Act 1987
4. Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

The statutory framework that applies varies spatially, depending on whether the project is on land, within 12 nautical miles of low tide or within New Zealand's Exclusive Economic Zone (Figure 3-1).

These Acts are reviewed in Chapters 5 and 6 of this report below.

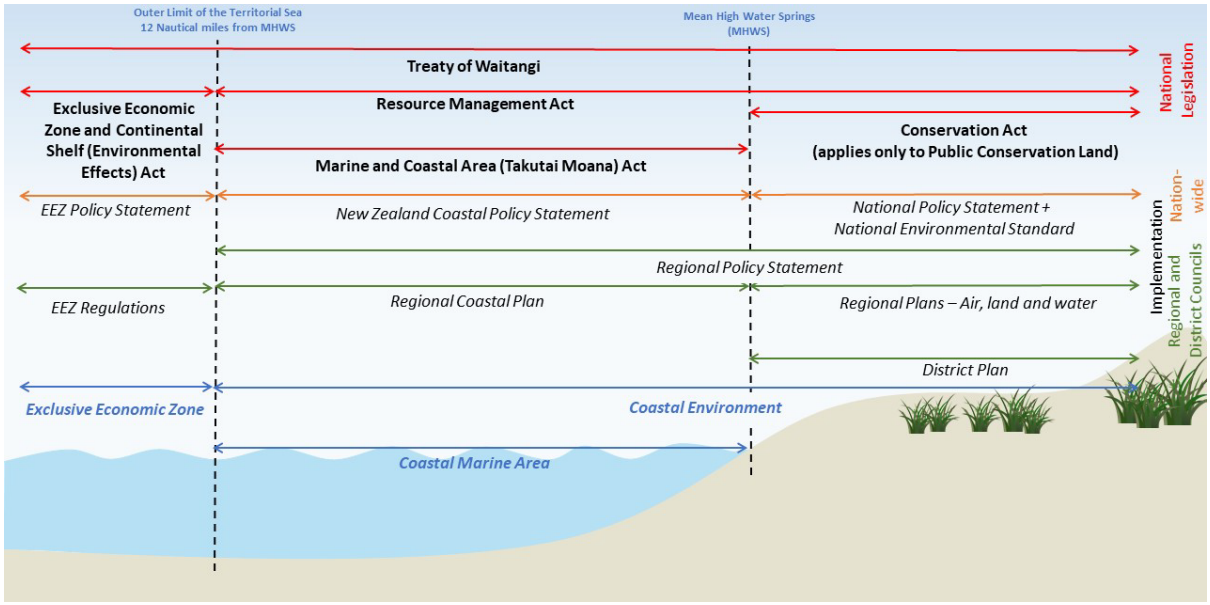

Figure 3-1 New Zealand's Environmental Statutory Framework

The Treaty of Waitangi is a central theme, and the legislation requires that the principles of the Treaty are taken into account (as a minimum). The Treaty is specifically referenced in the:

- Resource Management Act 1991 (RMA) – Section 8
- Conservation Act – Section 4
- Marine and Coastal Area (Takutai Moana) Act – Section 7

The Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 is the exception and does not contain provisions relating to the Treaty of the Waitangi. Instead, the EEZ Act provides for a Māori Advisory Committee to advise on marine consents, policy, process and decisions.

3.2 Overview: Other resource management legislation

Chapter 5 covers that applies to the use and development of geothermal resources including the Conservation Act, which applies to land owned within the Public Conservation Estate. It also covers legislation that applies offshore under the Marine and Coastal Area (Takutai Moana) Act and beyond this, to the exclusive economic zone under the Exclusive Economic Zone and Continental Shelf Act.

3.3 Overview: Energy, Climate and Mineral Legislation

A number of other pieces of legislation are relevant to the use of geothermal resources, these Acts are reviewed in Chapter 7:

- Energy Efficiency and Conservation Act 2000

- Climate Change Response Act 2002
- Rotorua City Geothermal Energy Empowering Act 1967
- Crown Minerals Act 1991

Chapter 8 of this report outlines how the statutory framework has been applied by Regional Councils in New Zealand where large scale geothermal development has occurred.

4 Resource Management Reform

During the development of this report, the Government announced its intent to repeal the RMA and replace it with new legislation.

This decision follows an independent review of the RMA undertaken with the view to *"…improving environmental outcomes and better enable urban and other development within environmental limits"* reported in "New Directions for Resource Management in New Zealand – Report of the Resource Management Review Panel June 2020" ("the Randerson Report") (Resource Management Review Panel, 2020).

The Randerson Report recommended that the RMA is replaced with three pieces of legislation. These changes present significant opportunity to engage in the development of the new legislation.

At the time of writing this report, the complete resource management reform process has not been confirmed but it has been indicated that the first Act(s) will be formally introduced at the end of 2021 and passed by the end of 2022.

The following sections summarise the existing legislative framework which will assist as a baseline position to effectively engage in the reform process.

5 Resource Management Act 1991 (RMA)

The Resource Management Act 1991 (RMA) was introduced as the overarching legislation for the management of effects on the environment, with the concepts of sustainable management, integrated management of resources, including geothermal resources and public participation at its core. It superseded a range of previous legislation relevant to geothermal resource use and development, including the Water and Soil Conservation Act 1967 and the Geothermal Energy Act 1953, and is the core framework applying to current geothermal development.

5.1 Purpose & Principles

Part 2 of the RMA outlines the purpose and principles of the Act. The purpose as outlined in s.5, is "to promote the sustainable management of natural and physical resources", which is further defined to mean:

> *"managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while—*
>
> *(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
>
> *(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
>
> *(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment."*

Sections 6, 7 and 8 address the key principles of the RMA that underpin how sustainable management will be achieved:

- Section 6 identifies 'matters of national importance' which relates to managing the use, development and protection of natural and physical resources, includes matters relating to natural character, outstanding natural features and landscapes, significant indigenous vegetation and habitats, the relationship of Māori and their culture and traditions with taonga, and natural hazard risks
- Section 7 identifies 'other matters' for which particular regard is required. Much of Section 7 is relevant to geothermal development including, of particular relevance:

  (a) Kaitiakitanga;

  (aa) the ethic of stewardship;

(b) The efficient use and development of natural and physical resources;

(ba) the efficiency of the end use of energy;

(i) the effects of climate change;

(j) the benefits to be derived from the use and development of renewable energy.

- Section 8 acknowledges the principles of the Treaty of Waitangi.

5.1.1 Using geothermal resources under the RMA

Section 14 of the RMA requires that no person may take, use, dam or divert water, heat or energy from the material surrounding geothermal water unless that is allowed by 14(3). Section 14(3) prohibits the taking, using, damming or diverting any water, heat or energy unless:

1. allowed by a national environmental standard, regional plan or resource consent, or
2. is in accordance with tikanga Maori for the communal benefit of the tangata whenua of the area and does not have an adverse effect on the environment.

Similarly, Section 15 of the RMA requires that no person may discharge contaminants into the environment (water, land or air), unless the discharge is allowed by a national environmental standard, a regional plan or a resource consent. The RMA defines a contaminant as including any substance, energy or heat that (either by itself or in combination with other substances, energy, or heat) changes or is likely to change the physical, chemical, or biological condition of water or land into which it is discharged. In this context, geothermal fluid containing heat, minerals or chemicals is a contaminant.

5.2 Roles and responsibilities

5.2.1 Central Government

New Zealand has three branches of Government:

3. The Legislature consists of Members of Parliament. The role of the Legislature is to make laws (legislation), and to scrutinise the Executive.
4. The Executive consists of Ministers (both inside and outside Cabinet) and Government departments. The role of the Executive is to decide policy, propose laws (which must be approved by the Legislature) and administer the law.
5. The Judiciary consists of all judges. The role of the judiciary is to interpret and apply the law. There are two main sources of law: statutes (the laws passed by Parliament) and the 'common law'. The common law has been developed by judges over the centuries, and may be altered by the courts to meet changing circumstances.

5.2.2 Local Government: Regional Councils

Section 30 of the RMA outlines the functions of Regional Councils. While their overarching role is to achieve the integrated management of natural and physical resources in the region, they have a particular role in controlling the use of land to ensure:

- soil conservation;
- the maintenance and enhancement of the quality of water in water bodies and coastal water;
- the maintenance of the quantity of water in water bodies and coastal water;
- the maintenance and enhancement of ecosystems in water bodies and coastal water;
- the avoidance or mitigation of natural hazards.

Regional Councils play a vital role in managing effects on the environment, including the use and development of geothermal resources, through the management of:

- Taking of water including geothermal water
- Taking or use of geothermal energy
- Taking or use of heat or energy from the material surrounding geothermal water
- Discharges to the environment of steam, stormwater, contaminated water (containing minerals and chemicals) and cooling water
- Use of land to construct geothermal wells and bores

Chapter 7 contains a brief overview of the approach to the use and development of geothermal resources taken by four Regional Councils in their regional policies statements and regional plans.

5.2.3 Local Government: District Councils

Section 31 of the RMA outlines the functions of territorial authorities, which is primarily focussed on the control of actual and potential effects from the use and development of land. The purpose of this control is:

- Avoidance or mitigation of natural hazards
- Prevention or mitigation of any effects of the development, subdivision or use of contaminated land
- Maintenance of indigenous biological diversity
- Control of the emission of noise and mitigation of noise effects
- Control any effects of activities on the surface of fresh waterbodies

In relation to the management of geothermal resources, District Council's play a key role in managing the effects of:

- Built structures and physical infrastructure associated with accessing, transporting/ distributing and using the geothermal resource,
- Managing effects associated with the construction of physical infrastructure including earthworks, noise, land contamination and protection of significant sites, and
- Operation, maintenance, repair, replacement, and upgrading of structures and associated physical infrastructure.

5.2.4 RMA Document Hierarchy

Figure 5-1 illustrates the hierarchy of documents and responsibilities for achieving the purpose of the RMA as discussed in the sections below.

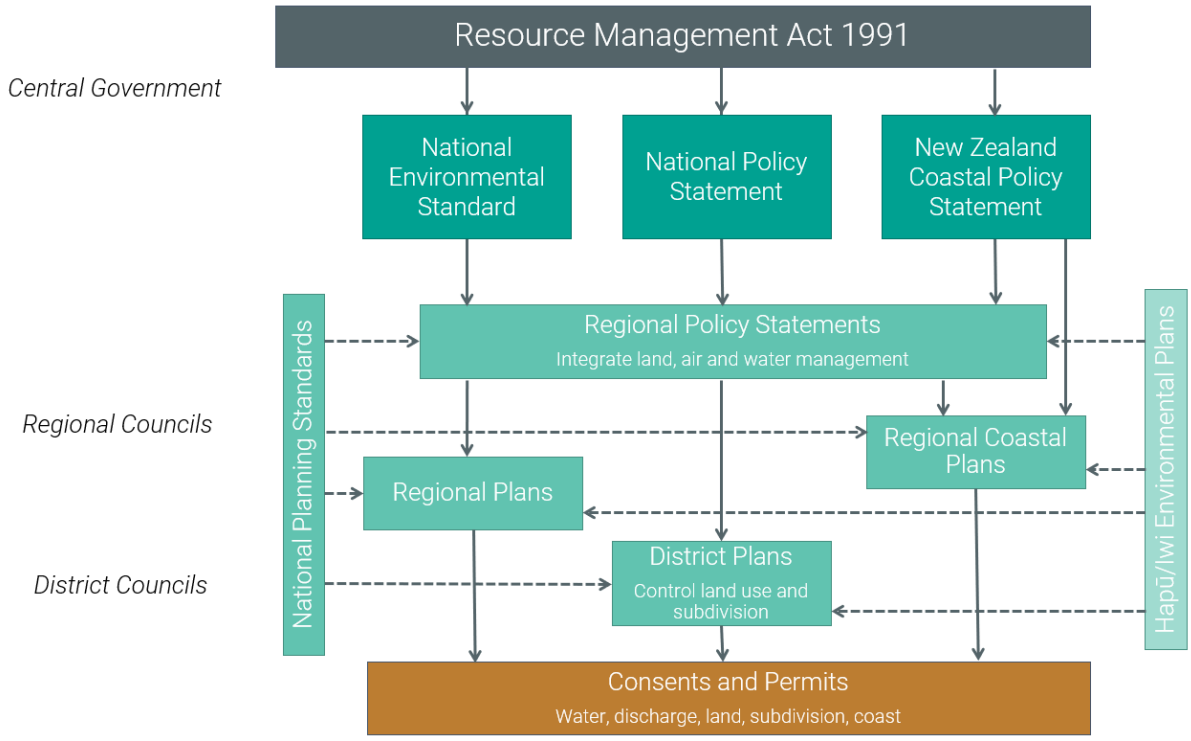

Figure 5-1 RMA Document Hierarchy

5.3 National Level Framework

5.3.1 National Policy Statements

A National Policy Statement (NPS) provides direction to local authorities and other decision-makers under the RMA on matters of national significance relevant to achieving the purpose of the RMA. The purpose of an NPS, outlined in s.45 of the RMA is "to state objectives and policies for matters of national significance that are relevant to achieving the purpose of the Act".

An NPS is able to apply generally New Zealand-wide, to any specified district or region or to any specified part of New Zealand.

An NPS sets objectives from a national perspective and identifies policies to achieve those objectives. These objectives and policies must then be recognised and responded to by decision-makers, such as local authorities, in their policy statements and plans prepared under the RMA (see Chapter 5.3.7 below). An NPS cannot direct decisions made under other legislation.

An NPS is prepared by the Minister for the Environment with exception for the New Zealand Coastal Policy Statement which is prepared by the Minister of Conservation.

Section 45(2) of the RMA outlines what the Minister for the Environment may have regard to when deciding whether to prepare an NPS. The following selected aspects are considered relevant when considering the use of geothermal resources:

- New Zealand's interests and obligations in maintaining or enhancing aspects of the national or global environment;
- anything which affects more than 1 region;
- anything which, because of its scale or the nature or degree of change to a community or to natural and physical resources, may have an impact on, or is of significance to, New Zealand;
- anything which, because of its uniqueness, or the irreversibility or potential magnitude or risk of its actual or potential effects, is of significance to the environment of New Zealand.

Currently New Zealand has NPSs for the following environmental matters:

- Urban Development
- Freshwater Management
- Renewable Electricity Generation
- Electricity Transmission
- New Zealand Coastal Policy Statement

The following are proposed National Policy Statements currently under development:

- Proposed NPS for Indigenous Biodiversity - which the government has consulted on and is due to be finalised for gazettal in late 2021. This proposed NPS has been in development since 2007. The proposed NPS is likely to be of particular relevance to geothermal vegetation affected by geothermal development, but information on its provisions is not currently available.
- Proposed NPS for Highly Productive Land – the government consulted on this in 2019 and if approved by Cabinet, will likely take effect in the second half of 2021.

Given their relevance to geothermal development, the National Policy Statement for Renewable Electricity Generation 2011, the National Policy Statement for Freshwater Management and the NZ Coastal Policy Statement 2010 are discussed further below.

5.3.2 National Policy Statement for Renewable Electricity Generation 2011

The NPS for Renewable Electricity Generation (NPSREG) provides national guidance to enable the sustainable management of renewable electricity generation and is currently the most applicable NPS to the use and development of geothermal resources. It has been designed to recognise the vital role of renewable energy in New Zealand and the contribution this makes to addressing the effects of climate change and in the wellbeing of people and the environment.

The preamble of the NPSREG outlines an intent to recognise that the benefits of renewable electricity generation can compete with matters of national importance identified in s6 of the RMA i.e. natural resources from which electricity is generated can coincide with areas of significant natural character, significant natural features and landscape or significant indigenous vegetation and significant habitats of indigenous fauna. There can also be conflict with the relationship of Māori with their taonga and their role as kaitiaki. The preamble also outlines an intent to provide national consistency in addressing competing values associated with the development of renewable energy resources to provide greater certainty to decision makers, applicants and the wider community.

The NESREG has a single objective:

> *To recognise the national significance of renewable electricity generation activities by providing for the development, operation, maintenance and upgrading of new and existing renewable electricity generation activities, such that the proportion of New Zealand's electricity generated from renewable energy sources increases to a level that meets or exceeds the New Zealand Government's national target for renewable electricity generation.*

The NPSREG has specific requirements in relation to geothermal resources and requires that Regional Policy Statements together with regional and district plans include objectives, policies and methods. This includes rules to provide for the development, operation, maintenance and upgrading of new and existing

electricity generation activities using geothermal resources to the extent applicable to the region or district[3].

5.3.3 National Policy Statement for Freshwater

The National Policy Statement for Freshwater 2020 seeks to manage freshwater resources in a way that prioritises the health and well-being of water bodies and freshwater ecosystems first, then the health needs of people including providing drinking water before finally considering the ability of people and communities to provide for their social, economic and cultural well-being now and into the future. This prioritised approach, includes the take and use of freshwater resources as well as management of discharges of water or contaminants and the effects of these discharges on freshwater resources.

5.3.4 New Zealand Coastal Policy Statement

The New Zealand Coastal Policy Statement 2010 (NZCPS) is the only mandatory national policy statement and is prepared by the Minister of Conservation. The coastal environment is identified as having characteristics, qualities and uses that pose particular challenges in achieving the sustainable management purpose of the RMA. The purpose of the NZCPS is to include policies in order to achieve the purpose of the RMA in relation to the coastal environment of New Zealand.

The seaward extent of the coastal environment is clearly defined and consistently applied as being the edge of the coastal marine area, being the outer limit of the territorial sea (12 nautical miles from the low tide mark), however the landward extent of the coastal environment is recognised by the NZCPS to vary from place to place depending on the characteristics of that place.

Provisions of particular note include Objective 6. This objective is relevant to the consideration of use and development of geothermal resources within the coastal environment. It recognises that the coastal environment contains renewable energy resources of significant value and enables people and communities to provide for their social, economic and cultural wellbeing and their health and safety through use and development.

Policy 6 (1) (g) relates to activities in the coastal environment and requires that the potential of renewable resources in the coastal environment be taken into account to meet the reasonably foreseeable needs of future generations.

Further, Policy 6 (2)(a) specifically relates to the coastal marine area and seeks to ensure that the potential use and development of renewable marine energy (from wind, waves, currents and tides) to contribute to meeting the energy needs of future generations is recognised for its potential contribution to social, economic and cultural wellbeing of people and communities.

[3] Policy E4 National Policy Statement for Renewable Energy Generation

5.3.5 National Environmental Standards

National Environmental Standards (NES) prescribe standards for environmental matters set by the Government to ensure a consistent standard for an activity or resource use.

An NES can prescribe technical and non-technical standards, methods or other requirements for land use and subdivision, use of the coastal marine area and beds of lakes and rivers, water take and use, discharges, or noise. Each regional, city or district council must enforce the same standard. In some circumstances, where specified in the NES, councils can impose stricter or more lenient standards.

Currently New Zealand has national environmental standards for the following environmental matters:

- Air quality
- Sources of drinking water
- Telecommunication facilities
- Electricity transmission activities
- Assessing and managing contaminants in soil to protect human health
- Plantation forestry
- Freshwater
- Marine Aquaculture

None of the existing NES have a direct relationship to the use and development of geothermal resources.

5.3.6 National Planning Standards

National Planning Standards were introduced to improve the consistency of council plans and policy statements, through standardised document structure, chapters, mapping and formatting as well as definitions. A first set of national planning standards, released in November 2019, include direction for councils about how certain matters, including the management and use of geothermal resources, should be included in planning documents.

The first set of standards are not yet implemented, but all Councils are required to do so by 2029 at the latest.

In relation to geothermal resources, the National Planning Standards require the response from planning documents outlined in Table 5-1 National Planning Standard requirements below.

Table 5-1 National Planning Standard requirements

Document type	Requirement relating to geothermal resources
Regional Policy Statement	Specific chapter "Geothermal" required in Part 3 – Domains and Topics
Regional Plan	Specific chapter "Geothermal" required in Part 2 – Management of Resources
Combined RPS, Regional and District Plans	Specific chapter "Geothermal" required in Part 3 – Domains
Combined RPS and Regional Plan	Specific chapter "Geothermal" required in Part 2 – Regional Policy Statement Domains + Specific chapter "Geothermal" required in Part 3– Regional Plan
District Plan	No specific requirements relating to geothermal resources

The introduction of National Planning Standards presents an opportunity for geothermal resources to be more uniformly addressed in future planning documents.

5.4 Regional and District Framework

5.4.1 Regional Policy Statements

Regional Councils are required to prepare a Regional Policy Statement (RPS) to provide an overview of resource management issues in the region and provide a policy framework to achieve the integrated management of natural and physical resources.

Section 62 of the RMA outlines what an RPS must contain, which includes objectives, policies and non-regulatory methods. An RPS cannot contain rules and must give effect to a National Policy Statement, a New Zealand Coastal Policy Statement, and a National Planning Standard.

5.4.2 Regional Plans & Regional Coastal Plans

Section 63 of the RMA outlines the purpose of regional plans, including regional coastal plans as: "The preparation, implementation, and administration of regional plans is to assist a regional council to carry out any of its functions in order to achieve the purpose of [the RMA]".

Regional coastal plans are intended, "to assist regional council, in conjunction with the Minister of Conservation, to achieve the purpose of the [RMA] in relation to the coastal marine area of that region".

A regional coastal plan can form part of a regional plan where this is appropriate to promote the integrated management of a coastal marine area and any related part of the coastal environment.

A regional plan must give effect to:

- any national policy statement; and
- any New Zealand coastal policy statement; and
- a national planning standard; and
- any regional policy statement.

A regional plan must not be inconsistent with a water conservation order or any other regional plan for the region.

Section 68 of the RMA outlines those matters that a Regional Council may develop rules for. Of particular relevance to geothermal resource use, Section 68(7) outlines:

> *Where a regional plan includes a rule relating to maximum or minimum levels or flows or rates of use of water, or minimum standards of water quality or air quality, or ranges of temperature or pressure of geothermal water, the plan may state—*
>
> *(a) whether the rule shall affect, under section 130, the exercise of existing resource consents for activities which contravene the rule; and*
> *(b) that the holders of resource consents may comply with the terms of the rule, or rules, in stages or over specified periods.*

5.4.3 Statutory Acknowledgements

A Statutory Acknowledgement is a formal acknowledgement by the Crown that recognises the particular cultural, spiritual, historical and traditional association of iwi with a site of significance or resource identified as a statutory area. The RMA requires that Statutory Acknowledgements be included in relevant regional and district statutory planning documents and that regard is had to them in resource consent decision making.

Statutory Areas relate to Crown-owned land and include areas of land, geographic features, lakes, rivers, wetlands and coastal marine areas. With respect to lakes, rivers and wetlands, a Statutory Acknowledgement excludes any part of the bed not owned or controlled by the Crown.

Table 5-2 details the Statutory Acknowledgements relevant, at the time of writing, to geothermal resources in New Zealand, for the regions that are the focus of this paper (Figure 2-2). It is acknowledged that future treaty settlement process may, as they are concluded, result in more acknowledgements being confirmed by the Crown.

Table 5-2 Statutory Acknowledgements relevant to current geothermal resources

Region	Geothermal Resource	Statutory Acknowledgement
Bay of Plenty Region	Kawerau Geothermal System	Ngāti Tūwharetoa (Bay of Plenty)
	Tarawera River	Ngāti Tūwharetoa (Bay of Plenty) & Ngāti Awa
	Rotorua Region Geothermal System	Affiliate Te Arawa Iwi/Hapū & Te Arawa Lakes
Waikato Region	Atiamuri geothermal field	Raukawa
	Mangakino geothermal field	Raukawa
	Okauia geothermal field	Raukawa
	Okoroire geothermal field	Raukawa
	Ongaroto geothermal field	Raukawa
	Taihoa geothermal field	Raukawa
	Whakamaru Hot Beach geothermal field	Raukawa
	Horohoro geothermal field	Affiliate Te Arawa Iwi/Hapū
	Waikite Waiotapu Waimangu geothermal field	Affiliate Te Arawa Iwi/Hapū
	Reporoa geothermal field	Affiliate Te Arawa Iwi/Hapū
	Atiamuri geothermal field	Affiliate Te Arawa Iwi/Hapū
	Te Kopia geothermal field	Affiliate Te Arawa Iwi/Hapū
	Orakei Korako geothermal field	Affiliate Te Arawa Iwi/Hapū
	Ohaaki/Broadlands geothermal field	Affiliate Te Arawa Iwi/Hapū
	Ngatamariki geothermal field	Affiliate Te Arawa Iwi/Hapū
	Rotokawa geothermal field	Affiliate Te Arawa Iwi/Hapū
	Tokaanu-Waihi-Hipaua geothermal field	Ngāti Tūwharetoa
	Horomatangi geothermal field	Ngāti Tūwharetoa

Region	Geothermal Resource	Statutory Acknowledgement
	Wairākei-Tauhara geothermal field	Ngāti Tūwharetoa
	Rotokawa geothermal field	Ngāti Tūwharetoa
Northland Region	Settlement process underway – no formal statutory acknowledgements at the time of writing.	

5.4.4 Hapū /Iwi Resource Management Plans

Iwi Management Plans or Iwi Environmental Management Plans are developed by Iwi authorities to outline environmental priorities and aspirations of an iwi, hapū or marae. These plans are a key starting point for recording hapū/iwi aspirations for the environment within their rohe. They also provide background understanding for local authorities in achieving the purposes of the RMA by recognising and providing for Māori cultural values and interests.

In particular hapū/iwi management plans:

- Assist to meet obligations under Part 2 of the RMA, by providing a general understanding of hapū/iwi values and interests in the natural and physical resources in a particular area;
- Must be taken into account when preparing or changing regional policy statements and regional and district plans (RMA Sections 61, 66, 74);
- Provide a starting point for consultation with iwi and hapū on council plans and policies (RMA Schedule 1 clause 3(1)(d), clause 3B, and clause 3C), by providing information to understand key issues and potential ways to resolve those issues;
- Provide a starting point for understanding potential effects of a proposed activity on Māori cultural values when making an application for resource consent (Section 88 and Schedule 4 of the RMA);
- May be cited in submissions and/or evidence relating to applications for resource consent, and decision-makers may have regard to Iwi management plans under Section 104(1)(c) of the RMA.

The RMA is silent on how iwi management plans are developed. This enables unique structure and content that can be tailored to the specific needs of the hapū/iwi.

5.4.5 District Plans

Like regional plans, the "purpose of the preparation, implementation, and administration of district plans is to assist territorial authorities to carry out their functions in order to achieve the purpose of [the RMA]".

District plans, administered by District Councils, cover issues related to the functions of territorial authorities. These include:

- The effects of land use
- The control of land use for the purposes of:
    - Avoiding or mitigating natural hazards,
    - The management of contaminated land,
    - The maintenance of indigenous biological diversity,
    - Noise, and
    - Activities on the surfaces of rivers and lakes.

District Plans are required to:

- state objectives for the district, policies to implement the objectives and rules to implement the policies; and
- give effect to:
    - Any national policy statement; and
    - Any New Zealand coastal policy statement; and
    - A national planning standard; and
    - Any regional policy statement.

District Plans must also not be inconsistent with a Regional Plan.

5.5 Resource Consents and Permits

A resource consent is the legal mechanism for allowing an activity to be undertaken that would otherwise contravene a rule in a regional plan, district plan or in a National Environmental Standard. In relation to geothermal development, resource consents are likely to be required for take and associated discharges of geothermal fluids and gases, land use for built structures, earthworks, visual amenity, infrastructure/roading and more.

Where a resource consent is required, the relevant regional plan, regional coastal plan, district plan or NES will determine whether the activity is a controlled, restricted discretionary, discretionary and non-complying activity (see Table 5-3). The different activity statuses outline what will be considered when deciding on a resource consent application and whether the resource consent must, can or cannot be granted.

Sometimes (as is often the case of larger scale geothermal development) resource consents will be required under more than one statutory document.

Table 5-3 Summary of Activity Status of Rules in Regional or District Plans

Activity Status	Resource Consent Required?	Comments
Permitted	No	There can be specific conditions or performance standards which need to be met
Controlled	Yes	Council must grant a resource consent for a controlled activity but can impose conditions on that consent
Restricted Discretionary	Yes	Council must limit the matters that they will consider when assessing the application and are only able to impose conditions on a consent in relation to these matters if granted. Consent can be declined.
Discretionary	Yes	Consent can be granted with conditions or declined. If granted the consent must comply with the requirements and conditions of the consent.
Non-complying	Yes	The consent authority may decline or grant the consent, with or without conditions. However, the consent can only be granted if the activity has no more than a minor effect on the environment or will not be contrary to the objectives and policies of the plan.
Prohibited	No resource consent can be applied for	No application for a resource consent may be made for the activity and the consent authority must not grant a consent for it.

5.5.1 Notification

Sections 95A-95G of the RMA specify the requirements for determining whether or not a resource consent application should be non-notified, limited or publicly notified. These sections take into account the rights of any protected customary rights group or customary marine title group, as well as considering the scale of the adverse effects arising from a proposed activity.

Non-notified consents are those which do not take into account the views of the public in the decision-making process. In these cases, the relevant consent authority makes the decision on the application without input from external parties.

Limited notified consents are those where the potential effects of the proposed activity are deemed by the relevant consent authority to be minor or more than minor (but are not less than minor) on any potentially affected person. Those parties identified as potentially affected by the proposed activity are

given the opportunity to submit in support or opposition of the application. Where submissions are received, and those submitters wish to be heard, a hearing is held by the consent authority. All parties to the application including the consent authority, the applicant and any submitters can make their case at the hearing. Once a decision issued, all parties have right to appeal decision to the Environment Court where mediation and/or an environment court hearing are then held. This can be a time consuming and litigious process.

For fully notified application, the process is the same as limited notified application. The key difference with a fully notified application is that anyone can make a submission on the application, except on matters relating to trade competition or the effects of trade competition, whether they are potentially affected by the application or not. As a result, the topics raised in submissions can be much wider and from a variety of different perspectives. A consent is considered to require full public notification where the relevant consent authority decides that the proposed activity will have or is likely to have adverse effects on the environment that are more than minor.

In relation to the consideration of adverse effects, public notification is required if the activity "will have, or is likely to have adverse effects on the environment that are more than minor". With regard to limited notification, where specifically affected parties are identified, notification of these parties is required when adverse effects of an activity on the "person are minor or more than minor (but are not less than minor)".

Most large scale geothermal resource consents have followed this notification process.

5.5.2 Projects of National Significance

Proposals deemed to be of National Significance can be referred directly a Board of Inquiry or the Environment Court for a Decision. Section 142 of the RMA provides for this through what is referred to as a "call in" by the Minister.

A proposal can be called in by the Minister for the Environment if a proposal has been lodged with a local authority and either, the Minister decides to apply s142 or the applicant or local authority request that the matter be decided by either a Board of Inquiry or the Environment Court.

Section 142(3) provides guidance on the factors that the Minister must have regard to when considering whether the proposal is one of National Significance. Of relevance to large scale geothermal resource use and development are the following guiding factors:

- has aroused widespread public concern or interest regarding its actual or likely effect on the environment (including the global environment); or
- involves or is likely to involve significant use of natural and physical resources; or

- affects or is likely to affect or is relevant to New Zealand's international obligations to the global environment; or
- involves or is likely to involve technology, processes, or methods that are new to New Zealand and that may affect its environment; or
- is or is likely to be significant in terms of section 8 in relation to obligations under the Treaty of Waitangi; or
- affects or is likely to affect more than 1 region or district; or
- relates to a network utility operation that extends or is proposed to extend to more than 1 district or region.

When deciding whether an application is one of National Significance, the Minister must consider the views of the applicant and the local authority, the ability of the local authority to process the application and any recommendation from the Environmental Protection Agency (EPA).

Proposals that are called in are required to be fully publicly notified.

At the time of writing, the EPA has processed 16 proposals of National Significance including the two geothermal resource consent applications for the development of the Te Mihi Power Station in 2008 and the Tauhara II Geothermal Power Station in 2010.

5.5.1 Direct referral

Should a proposal not be considered of National Significance, but is large scale and/or complex, there is provision in the RMA for the application to be referred directly to the Environment Court for a decision.

Direct referral is the ability of applicants to make a request that their notified resource consent be decided by the Environment Court, rather than the relevant council. This process for resource consents, provided for under sections 87C to 87I of the RMA is intended to streamline decision-making for notified resource consents. It is designed for an application that may be more contentious where opposition to the proposal is likely and where Environment Court appeals are anticipated. The direct referral process is intended to save time and costs for both applicants and submitters by avoiding the need for a 2-stage hearing process at Council level and then at the Environment Court should a Council decision be appealed (refer to Section 5.5).

To date, this process has not been followed for large scale geothermal developments.

5.5.2 Consent Duration

Once granted, a resource consent may have an expiry date applied to it, after which time the activity must cease or a new application made, this is particularly relevant in the case of a permit to take or discharge water or contaminants. This gives the consent authority the opportunity to review the state of the

resources being used and to require modifications to an activity if there are effects that were not anticipated or are greater in scale or nature that what was originally consented.

Section 123 outlines that the duration of any resource consent. While a land use or subdivision consent can be unlimited, this does not apply to any consent which is required for activities in the beds of lakes or rivers (under Section 13 of the RMA). Similarly, it does not apply to permits for the taking or use of water, or the discharge of contaminants to the environment (under Sections 14 and 15 respectively). For these activities, the maximum duration of a resource consent is 35 years, and if no duration is specified, the consent is only granted for 5 years. Longer consent durations give greater certainty to an applicant for the ongoing operation of the activity.

It is noted that where the planning policy framework, or interpretation of the Act changes during the period of the consent, this can pose a threat to the renewal of a consent, even in the instance where effects of the activity have not materially changed.

Section 128 of the RMA outlines the circumstances when consent conditions can be reviewed. This includes: s128(1)(b) in the case of a water or discharge permit, when a regional plan has been made operative, which includes rules relating to maximum or minimum flows or rates of use of water, or minimum standards of water quality or air quality, or ranges of temperature or pressure of geothermal water. The regional council must also consider if it is appropriate to review the conditions of a permit to ensure the levels, flows, rates or standards set by the rule are met.

5.5.3 Designations

Designations are a tool in a District Plan that can be used for a public project or work. A designation effectively replaces the rules in a District Plan with a specific activity status for that land, such as a road or wastewater treatment plant. A designation provides for the activities of the Requiring Authority[4] in accordance with the designation without requiring resource consent under the District Plan.

A designation also offers protection to the public project or work by placing restrictions on any activities that could prevent the activity or work from occurring, without written consent of the requiring authority.

Designations, and conditions imposed on them, are described in the District Plan and indicated on District Plan maps which makes it clear for plan users what the purpose of the site/land is.

[4] A requiring authority is defined in the RMA as being a Minister of the Crown, local authorities and network utility operators who have been approved by the Minister of the Environment. A network utility operator includes a person who undertakes the distribution or transmission by pipeline or geothermal energy as provided by Section 166 of the RMA.

Designations, including in the case of designations for the use of geothermal resources, provide security for the requiring authority that the use of land for the purpose of accessing and using geothermal resources is secured. They also provide guidance to District Plan users about the protected use of the designated land.

For geothermal resource use and development, the consenting framework of primary relevance is the Regional Plan due to the associated taking, use of water resource and discharge of contaminants. As a result, there is likely limited practical application for designations relating to geothermal development projects. Potential exemptions to this include designations for the protection of future development such as pipeline corridors and the corridors for electricity transmission lines associated with a geothermal development.

6 Other Relevant Resource Management Legislation

In addition to the direction provided through the RMA, there are other pieces of legislation relevant when considering the use and development of geothermal resources. As identified on Figure 3-1, this includes:

- Conservation Act – relevant to land held within the Public Conservation Estate managed by the Department of Conservation
- Marine and Coastal Area (Takutai Moana) Act – for the area of the coast between Mean High Water Spring (MHWS) (effectively the high tide line) and the outer limit of the territorial sea, 12 Nautical Miles from MHWS
- Exclusive Economic Zone and Continental Shelf Act – relevant to the area beyond 12 Nautical miles from MHWS.

Each of these pieces of legislation is considered in more detail in the sections below.

There are currently no extractive geothermal activities being undertaken within the MCA or the EEZ nor within the Public Conservation Estate.

6.1 Conservation Act 1987

The Conservation Act 1987 provides for the protection of natural and historic resources generally, and within the public conservation estate (PCE) (Figure 6-1) and promotes the benefits of the conservation of natural and historic resources to present and future generations.

Section 4 of the Conservation Act requires that the Act be interpreted and administered to give effect to the principles of the Treaty of Waitangi.

The PCE includes crown owned land held in National Parks and land in parks and reserves including forest parks, conservation areas, conservation parks and marine reserves/sanctuaries. Currently, there is no geothermal development within the PCE.

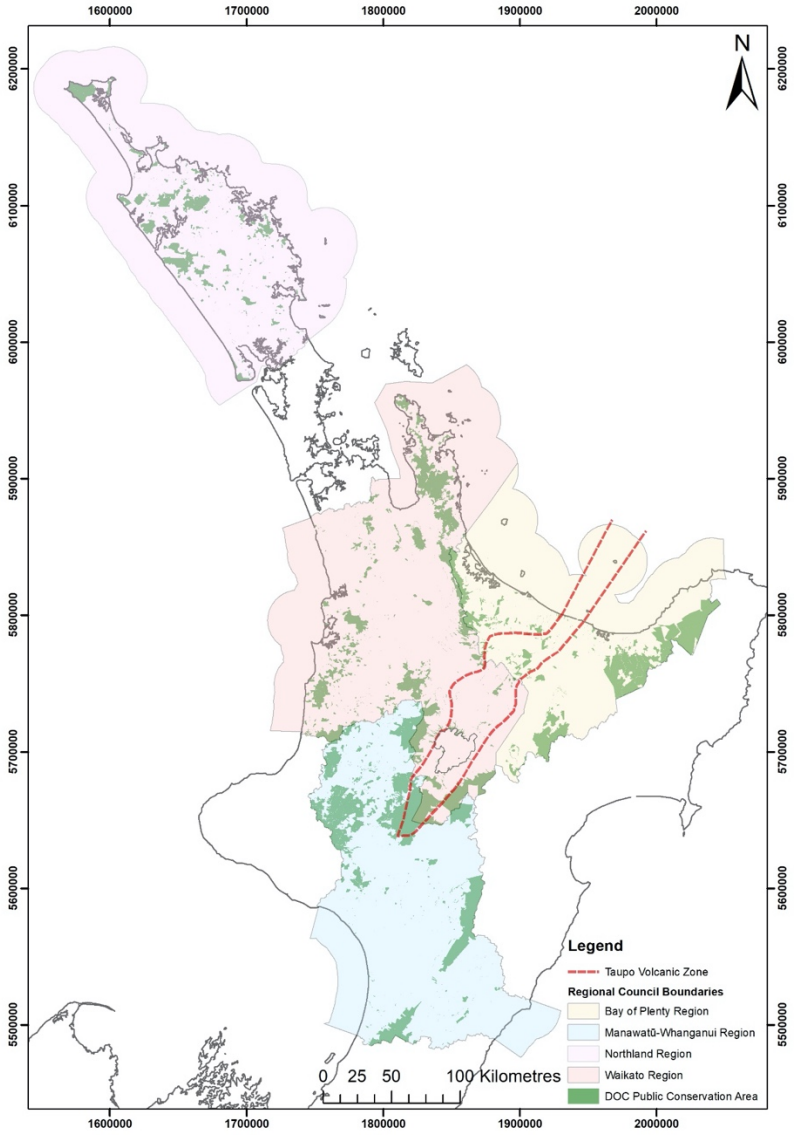

Figure 6-1 Extent of the Public Conservation Estate in Regions that include a part of the Taupo Volcanic Zone or the Ngawha geothermal field.

6.1.1 Policies & Plans

The PCE is managed through the application of the following statutory documents[5]:

- Conservation General Policy – broad policies reflecting the wide range of conservation areas and conservation tasks performed under the Conservation Act and several other Acts.
- Conservation Management Strategies – 10-year regional conservation strategies providing an overview of conservation issues and a direction for managing public conservation land and giving effect to the conservation general policy.

[5] https://www.doc.govt.nz/about-us/our-policies-and-plans/

- **Conservation Management Plans** – 10-year plans used to give effect to the conservation management strategy, they establish detailed objectives for the integrated management of natural and physical resources in a particular area and are developed for areas where there is a greater role for iwi/hapū/whānau in the management of the area.
- **National Park Management Plans** – 10-year management plans which also give effect to the Conservation General Policy and provide National Park specific management objectives.

The relationship between these statutory plans and policies is illustrated in Figure 6-2 below.

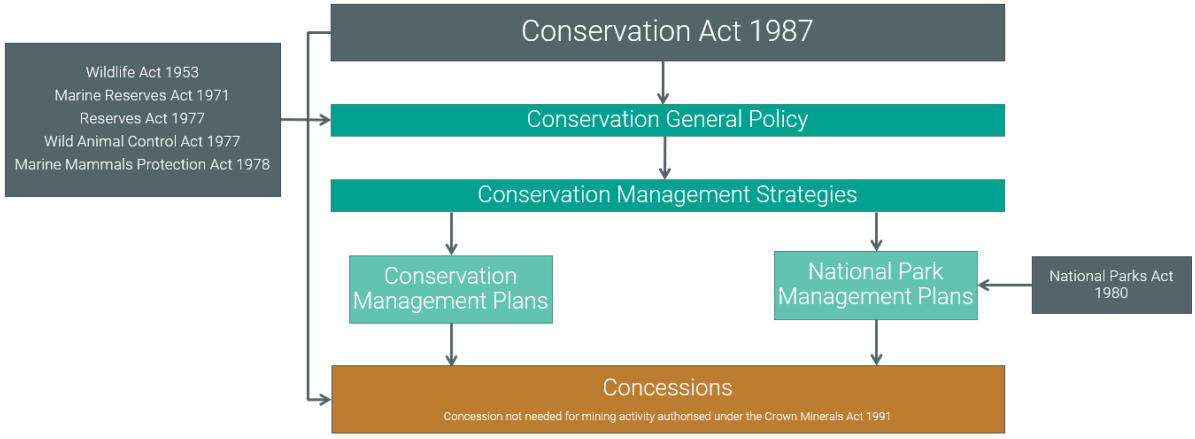

Figure 6-2: Conservation Act Document Hierarchy

6.1.2 New Zealand Conservation Authority

The New Zealand Conservation Authority (NZCA) was formed under the Conservation Act as the national statutory body providing strategic advice to the Department of Conservation and the Minister of Conservation.

Conservation Boards are regionally based groups that are appointed to provide an opportunity for local contribution into the management of conservation areas.

6.1.3 Regulatory Approvals

Use of geothermal resources located within the public conservation estate requires consideration and approval under both the Resource Management Act and the Conservation Act. Authorisations under the Conservation Act, via concessions, enable private or commercial activities to occur on conservation lands.

In practice, it is acknowledged that regulatory approvals are difficult under the Conservation Act unless specific provision is made for the use and development of geothermal resources within the statutory documents developed outlined in Section 6.1.1 above.

6.2 Marine and Coastal Area (Takutai Moana) Act 2011

While the RMA is the overriding legislation for managing activities in the coastal marine area, the Marine and Coastal Area (Takutai Moana) Act 2011 (MCA), which replaced the 2004 Foreshore and Seabed Act, also applies (Figure 3-1).

The purpose of the MCA, outlined in Section 4, is to:

> *(a) establish a durable scheme to ensure the protection of the legitimate interests of all New Zealanders in the marine and coastal area of New Zealand; and*
>
> *(b) recognise the mana tuku iho exercised in the marine and coastal area by iwi, hapū, and whānau as tangata whenua; and*
>
> *(c) provide for the exercise of customary interests in the common marine and coastal area; and*
>
> *(d) acknowledge the Treaty of Waitangi (te Tiriti o Waitangi)*

In order to take account of the Treaty of Waitangi, the MCA recognises, and promotes the exercise of, the customary interests of iwi, hapū, and whānau in the common marine and coastal area of New Zealand. The MCA provides for the special status of the common marine and coastal area and guarantees public access. The application of the MCA is defined as the area between the line of mean high water springs (the landward boundary of the part of the beach covered by the ebb and flow of the tide) and the outer limits of the territorial sea (12 nautical miles). It excludes existing private titles, the bed of Te Whaanga Lagoon in the Chatham Islands and certain conservation areas.

The MCA ceases to apply at the outer limit of the territorial sea at which point the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act applies.

The MCA creates special rules for people applying for resource consent in areas where there are customary interests, such as protected customary rights and customary marine title. Any resource consent applicant seeking to undertake activities within the marine and coastal area will need to consider whether any customary interests exist and where they do, ensure that consultation is undertaken with the relevant group to consider adverse effects on any protected customary rights or marine titles.

There are currently no extractive geothermal activities being undertaken within the MCA or the EEZ.

6.3 Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

The Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (EEZ Act) was developed to address gaps in the management of the marine environment in New Zealand.

The RMA and Crown Minerals Act (see Chapter 7) provide for integrated management of the effects of activities within NZ's territorial boundary extending out to 12 nautical miles from the low tide line. The EEZ Act covers those areas of the sea, seabed and subsoil that are between 12 to 200 nautical miles from the coast, measured at Mean High Water Spring (See Figure 3-1).

The EEZ Act places restrictions on activities and discharges within the Exclusive Economic Zone (EEZ) or the Continental Shelf[6] (See Figure 6-3).

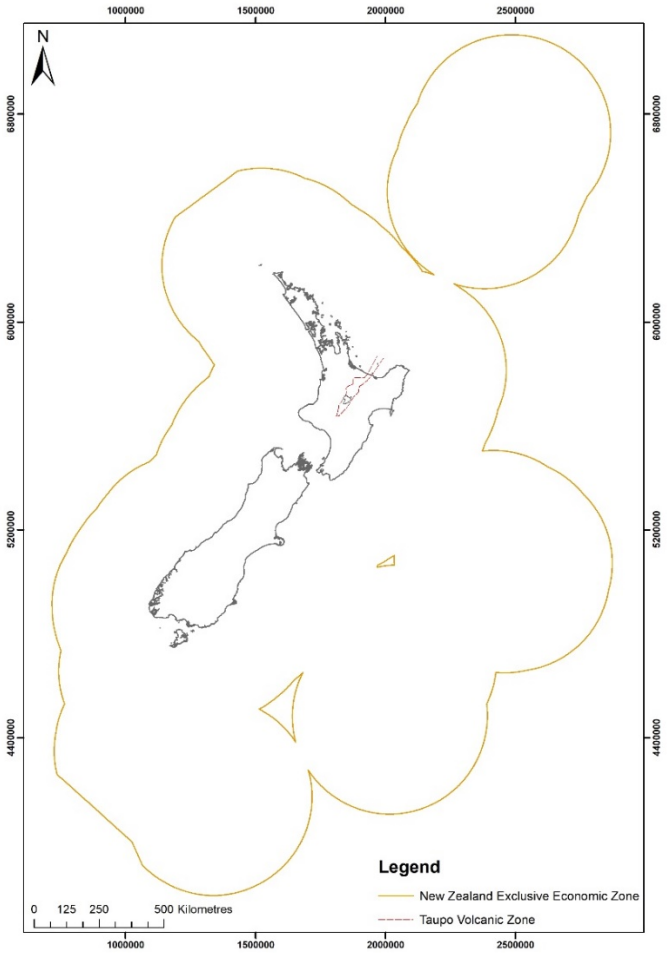

Figure 6-3 Extent of New Zealand's Exclusive Economic Zone

[6] Defined to mean "the seabed and subsoil of those submarine areas that extend beyond the territorial limits of New Zealand, throughout the natural prolongation of the land territory of New Zealand, to the seaward-side boundaries" under the Continental Shelf Act 1964

The EEZ Act provides a management and decision-making framework for managing the effects of activities in the Exclusive Economic Zone and Continental Shelf. The Minister for the Environment is responsible for making regulations.

Currently there are regulations relating to the following:

- Permitted activities under the Exclusive Economic Zone and Continental Shelf (Environmental Effects—Permitted Activities) Regulations 2013 which cover:
    - regulations classifying certain activities as permitted - these cover Section 20 activities carried out as part of:
        - seismic surveying
        - prospecting and exploration phases of seabed mineral mining and petroleum (excluding exploratory oil and gas drilling)
        - submarine cabling
        - marine scientific research
    - regulations for cost recovery - for the Environmental Protection Authority's functions under the Act.
- Non-notified discretionary activities under the Exclusive Economic Zone and Continental Shelf (Environmental Effects—Non-notified Activities) Regulations 2014 which cover:
    - Activities associated with the exploration drilling for petroleum in the exclusive economic zone or in or on the continental shelf such as:
        - the construction, placement, alteration, extension, removal, or demolition of a structure submarine pipeline on or under the seabed:
        - the abandonment of a submarine pipeline that is on or under the seabed:
        - the placement, alteration, extension, or removal of a submarine cable on or from the seabed:
        - the disturbance of the seabed or subsoil in a manner that is likely to have an adverse effect on the seabed or subsoil:
        - the deposit of any thing or organism in, on, or under the seabed:
        - the destruction, damage, or disturbance of the seabed or subsoil in a manner that is likely to have an adverse effect on marine species or their habitat.
- Discharges and dumping activities under the Exclusive Economic Zone and Continental Shelf (Environmental Effects— Discharge and Dumping) Regulations 2015 which cover:
    - Permitted discharge activities subject to conditions including:
        - Discharge down petroleum well

        - Discharge of oil mixed with water from machinery space
        - Discharge of seawater contaminated with oil
        - Discharge of grey wate and sewage
    - Discretionary activities including:
        - Discharge from petroleum extraction activities
        - Discharge of harmful substances from mining activities
        - Discharge of drilling fluids
    - Prohibited activities including:
        - Discharge of segregated ballast water contaminated with oil.

Future use and development of geothermal resources in the EEZ could warrant the consideration of a new regulation or amendments to the existing regulations.

Section 61(2) of the EEZ Act includes a requirement for decision makers, that if the information available is uncertain or inadequate, caution and environmental protection much be favoured. This places a high burden of proof on an applicant with regard to the information presented to support an application.

6.3.1 Consent Applications in the EEZ

The Environmental Protection Agency (EPA) is responsible for deciding on applications for marine consents and monitoring and enforcing compliance with the EEZ Act.

Where an activity crosses the boundary between the jurisdictions of the RMA and the EEZ Act, there is the option to either apply as a single application under the requirements of both Acts, or to apply for a marine consent and a resource consent separately. This process is administered by the EPA, but separate decisions under the relevant criteria of the EEZ Act and the RMA must be made.

Any applications for the future geothermal resource use and development located offshore, within Exclusive Economic Zone, would be decided by the EPA.

6.3.2 Treaty of Waitangi

Section 12 of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act outlines requirements to recognise and respect the Crown's responsibility to give effect to the principles of the Treaty of Waitangi including through:

- Section 18 which provides for the Māori Advisory Committee to advise marine consent authorities to ensure decisions are informed by a Māori perspective;

- Section 32 which requires the Minister to establish and use a process the ensures iwi have adequate time and opportunity to comment on the content of proposed regulations;
- Sections 33 and 50 which require the Minister and any marine consent authority to take into account effects of activities on existing interests; and
- Section 47 which requires the Environmental Protection Authority (EPA) to notify iwi authorities, customary marine title groups and protected customary rights groups directly of consent applications that may affect them.

6.3.3 EEZ policy statements

EEZ Policy Statements were introduced into the EEZ Act through an amendment in 2017[7]. The purpose of these statements is not dissimilar to that of a National Policy Statement under the RMA to "state objectives and policies to support decision-making on applications for marine consents in accordance with the purpose of the [EEZ] Act".

An EEZ policy statement may apply to all or part of the EEZ and the continental shelf and provides national direction for decision makers. There are currently no proposed or operative EEZ Policy Statements.

There is an opportunity for the development of a future EEZ Policy Statement to support the use and development of geothermal resources within the EEZ.

[7] Section 37A of Resource Legislation Amendments Act 2017

7 Energy, Climate Change & Mineral Legislation

The following sections explore pieces of New Zealand legislation which a focus on energy, climate change and the extraction and use of minerals. These pieces of legislation are also relevant to the use and development of geothermal resources in addition to those identified in Sections 4 and 5 above.

7.1 Climate Change Response Act 2002

The Climate Change Response Act 2002 (CCR Act) puts in place a legal framework to enable New Zealand to meet its international obligations under the United Nations Framework Convention on Climate Change 1992 (the Convention) and the Kyoto Protocol 1997 (the Protocol). The CCR Act provides for the implementation and operation of the Emissions Trading Scheme and the establishment of the Climate Change Commission.

The CCR Act also establishes a national inventory agency to record and report information relating to New Zealand's human-induced greenhouse gas emissions and reporting on New Zealand's obligations in accordance with international requirements.

In 2019, the CCR Act was amended through the Climate Change Response (Zero Carbon) Amendment Act. These amendments provide a framework by which New Zealand can develop and implement clear and stable climate change policies that:

- contribute to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5 degrees Celsius above pre-industrial levels
- allow New Zealand to prepare for, and adapt to, the effects of climate change.

Advice from the Climate Change Commission (He Pou a Rangi) ("CCC") was provided to the government in mid-2021 and provides Advice to the New Zealand Government on its first three emissions budgets to 2035 and direction for its emissions reduction plan 2022 – 2025.

The CCC's approach is to set a renewable energy target (50% renewable by 2035). Geothermal resources will support decarbonisation of electricity generation and process heating uses.

7.1.1 New Zealand Emissions Trading Scheme

The New Zealand Emissions Trading Scheme (NZETS) is the main Government tool for meeting international and domestic climate change targets. It is intended to encourage the reduction of greenhouse gas emissions through creating a financial incentive for reductions and enabling landowners to earn money by planting forests that absorb carbon dioxide as the trees grow.

Under the NZETS, one emission unit (NZU), represents one metric tonne of carbon dioxide or carbon dioxide equivalent (i.e. the amount of another greenhouse gas that has the same impact as one tonne of carbon dioxide on the environment).

Participation in the NZETS can occur in three ways:

- By those who have obligations to surrender NZUs when they carry out certain activities (obligation to participate) – applies currently to forestry, energy, industry, liquid fossil fuels, synthetic gases, waste.
- By those who have opportunities to earn NZUs (optional participation) – applies only to forestry.
- By those who will be allocated NZUs as compensation for increased costs under the NZETS. They can trade their allocation of NZUs – applies to forestry, fishing and industry.

7.1.1.1 Climate Change (Stationary Energy and Industrial Processes) Regulations (2009)

Those who use geothermal fluid, including geothermal steam or two-phase fluid, to generate electricity or industrial heat are required to participate in the NZETS. These regulations provide direction on the requirements for participants including collection and recording of information and calculating emissions.

The Ministry for the Environment provides a "Guide to reporting for geothermal fluid activities under the New Zealand Emissions Trading Scheme"[8] for people who use geothermal fluid to generate electricity or industrial heat on their requirements under the NZETS.

The NZETS requires that stationary energy participants monitor and report their greenhouse gas emissions using specific criteria.

Regulation 19 relates to the collection and recording of information for the purpose of calculating emissions from using geothermal fluid. It requires the collection of the following information:

- tonnes of each class of geothermal production steam used:
    a. including both high pressure and low pressure steam:
        i. resulting from all flashes of geothermal fluid
        ii. obtained directly from geothermal wells
        iii. released as an emergency discharge

[8] https://www.mfe.govt.nz/publications/climate-change/guide-reporting-geothermal-fluid-activities-under-new-zealand-emission-3

b. excluding any steam associated with:

i. well testing and bleeding

ii. the disposal of spent geothermal fluid

iii. unused but maintained geothermal wells

- tonnes of each class of 2-phase geothermal fluid used, including all geothermal fluid as recorded at geothermal fluid transmission monitoring points or provided in point of sale information

In relation to the use of geothermal steam, the regulation provides in Schedule 2 emissions and oxidation factors and includes, as Table 6, a list of the locations where geothermal steam and fluid are used and a specific default emissions factor for each site.

Regulation 20 provides a method of calculating emissions from using geothermal steam and fluid. The calculation provided is

$$\boldsymbol{Emissions = A(Activity\ data)x\ EF(Emissions\ Factor)}$$

The activity data is the amount of a product, either steam or 2-phase geothermal fluid, that will result in emissions. Emissions factors are specific to the identified plant, not to the geothermal field.

There is a specific process for registering as a participant under the NZETS, which is a mandatory requirement for geothermal fluid users. A geothermal fluid user is also able to apply to use a unique emissions factor (UEF) for a particular geothermal plant which allows recognition for plant technology changes resulting in reduced emissions and to subtract emissions associated with the reinjection of non-condensable gases.

7.2 Energy Efficiency and Conservation Act 2000

The purpose of the Energy Efficiency and Conservation Act 2000 (EEC Act) is to promote energy efficiency, energy conservation, and the use of renewable sources of energy.

Section 6 of the EEC Act specifies the sustainability principles that must be taken into account by all persons exercising responsibility, powers or functions under the EEC Act. They are:

(a) the health and safety of people and communities, and their social, economic, and cultural well-being; and

(b) the need to maintain and enhance the quality of the environment; and

(c) the reasonably foreseeable needs of future generations; and

(d) the principles of the Treaty of Waitangi.

The New Zealand Energy Efficiency and Conservation Strategy 2017-2022 (NZEECS) developed under the EEC Act is the overarching policy direction for the promotion of energy efficiency, energy conservation and the use of renewable sources of energy. The goal of the strategy is for New Zealand to have an energy-productive and low-emissions economy.

NZEECS identifies three priority areas:

- Renewable and efficient use of process heat – the target for this priority area is to decrease industrial emissions intensity by at least 1% per annum.
- Efficient and low-emissions transport – the target for this priority area is that electric vehicles make up 2% of the vehicle fleet by end of 2021.
- Innovative and efficient use of electricity – the target for this priority area is to achieve 90% electricity generation from renewable sources by 2025.

Geothermal activity currently contributes to the outcomes sought by NZEECS and through the generation of electricity and direct use of geothermal heat.

7.3 Rotorua City Geothermal Energy Empowering Act 1967

The Rotorua City Geothermal Energy Empowering Act 1967 (RCGEE Act) enables the Rotorua City Council to supply geothermal energy for the industrial, commercial and domestic use in Rotorua. It provides for the sinking of bores and the take, tap or use of geothermal energy from them and the prospecting for geothermal energy by bore or any other method. It essentially replaced the Geothermal Energy Act 1953 in the area of Rotorua city.

This RCGEE Act delegated the power to issue licenses (revoked in 1986) and make bylaws for geothermal bores to the Rotorua City Council and any geothermal works under this Act are to be vested in the Corporation of the city.

The requirements of this Act apply in addition to the requirements of the Resource Management Act.

7.4 Crown Minerals Act 1991

The purpose of the Crown Minerals Act ("CM Act") is to promote prospecting for, exploration for and mining of Crown-owned minerals for the benefit of New Zealand.

The CM Act outlines that the crown owns all petroleum, gold, silver and uranium as well as all minerals on or under Crown land.

The CM Act controls the issuing of minerals programmes which allocate the right to prospect, explore or mine Crown-owned mineral resources. There are separate programmes for petroleum and other minerals

which set out policies and procedures for allocating minerals and also include specific requirements for consultation with iwi and hapū.

7.4.1 Application of the Crown Minerals Act to Geothermal Development

The extraction of minerals can be an ancillary activity associated with the extraction of geothermal water and fluid, as minerals are contained within the material extracted and used for energy (see Chapter 2.2).

The extent that water, including geothermal water, as defined in the Resource Management Act, includes the minerals "dissolved or entrained" in the water is considered by Barton in his report on "Legal Rights to Minerals in Geothermal Fluids" (2015). He resolves that the management of water under the RMA includes the granting of rights to the minerals in water, including the minerals found in geothermal water and fluids.

Essentially, this means that minerals in geothermal water and fluid are owned by the Crown but the holder of a resource consent to take and use water, has rights to also take and use any minerals contained within that water. The definition of mineral under the CM Act, is also explored by Barton. He considers that once a mineral is extracted, including minerals within geothermal water or fluids, and are no longer "beneath or at the surface of the earth, whether or not underwater", they are no longer subject to the CMA and instead have the status of personal property.

Barton also considers whether accessing and extracting geothermal water/fluids and any associated minerals is consistent with the definition of mining under the CM Act. He does not reach a clear position on the matter. On one hand, he considers that there is a lack of clarity around whether mining includes the extraction of minerals. This is because the minerals are essentially an ancillary outcome to the extraction of the geothermal water/fluid unlike, for example, the extraction of oil and gas where the primary purpose is to extract the mineral material. He suggests that due to the primary purpose of geothermal resource extraction being to extract energy, the subsequent extraction of mineral 'by-products' within the water/fluid is exempt from the requirements of the CM Act for mining.

While there remains uncertainty around whether extracting geothermal water/fluids and associated minerals constitutes mining, there is a risk of proceeding without approvals under the CM Act.

7.4.2 Review of Crown Minerals Act 1991

A review of the CM Act 1991 commenced in November 2019 with the intention to ensure the CM Act realises the Government's vision in the Mineral and Petroleum Strategy for Aotearoa New Zealand: 2019-2029 of a "world-leading environmentally and socially responsible minerals and petroleum sector that delivers affordable and secure resources, for the benefit of current and future New Zealanders".

The review seeks to achieve the following 3 objectives:

Objective 1: Encourage the development of Crown-owned minerals so that they contribute more to New Zealand's economic development.

Objective 2: Streamline and simplify the regime where appropriate, ensuring it is in line with the regulatory reform agenda, and make it better able to deal with future developments.

Objective 3: Ensure that better coordination of regulatory agencies can contribute to stringent health, safety and environmental standards in exploration and production activities.

There may be an opportunity within this review for clarification around the application of the CM Act in relation to minerals in geothermal fluids.

8 Geothermal Planning Framework

Each Regional Council develops their own Regional Policy Statement and Regional Plan(s) under the RMA to address the issues of their region. Until the recent introduction of National Planning Standards (discussed above in Chapter 5.3.6), there was no specific format for the development of these planning documents.

However, despite the introduction of the planning standards which require a geothermal domain chapter and an energy and infrastructure chapter and should ensure consistent structure within the documents, the management of the use and development of geothermal resources can be interpreted and implemented in a variety of ways by each Regional Council.

The following chapter provides a brief overview of the approach to the use and development of geothermal resources taken by four Regional Councils (Figure 8-1): Northland; Waikato; Bay of Plenty and Manawatū-Whanganui. The chapter focusses on the three regions where large-scale, high temperature geothermal development has occurs (Luketina, 2000) (Figure 2-2 and Figure 2-3). Manawatū-Whanganui (Horizons) Region is also explored due to its location at the southern end of the Taupō Volcanic Zone.

While there is undoubtedly potential, there is currently no geothermal resource use located offshore.

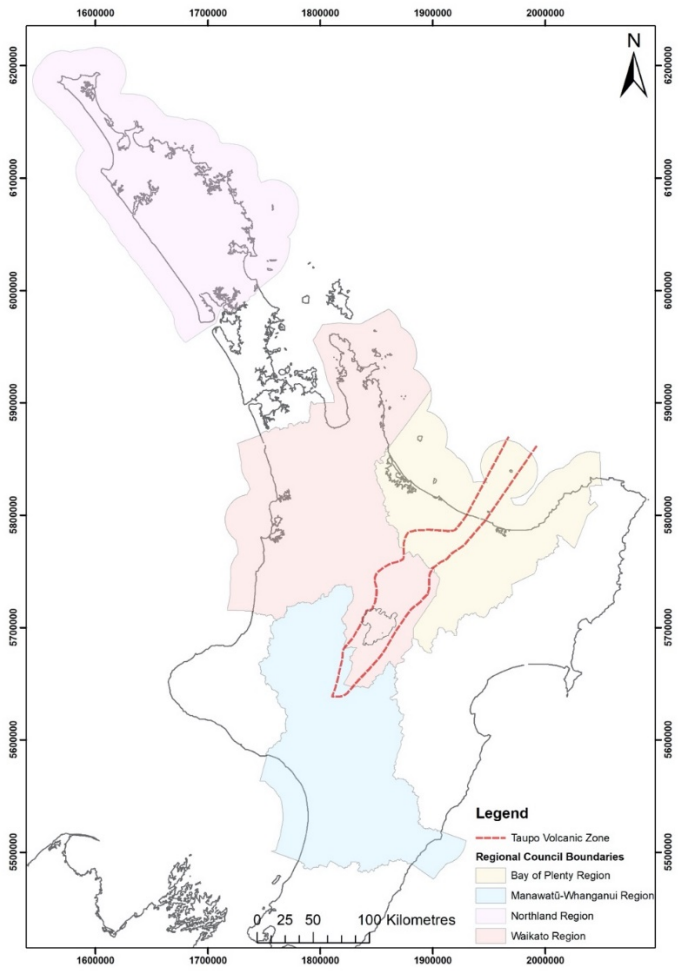

Figure 8-1 Northland, Waikato, Bay of Plenty and Manawatū-Whanganui Regional Council boundaries

8.1 Bay of Plenty Regional Council

8.1.1 Regional Policy Statement

The Bay of Plenty Regional Policy Statement (Operative October 2014) includes a specific section regarding the management and use of geothermal resources and identifies the following regionally significant resource management issues of relevance:

- Effects on the intrinsic values of geothermal systems from surrounding land uses, groundwater use and use of water from the geothermal system.
- Allocation of geothermal resources – recognising the challenges with balancing the use of geothermal resources and protecting their values.
- Lack of information about regional geothermal resources and the effects of their use.

- Need for integrated management due to the interconnected nature of geothermal resources at a regional and inter-regional level to allow for its sustainable management.

Objectives are included in the RPS which seek to ensure holistic and sustainable management of the region's geothermal resources through the protection of some systems with Significant Geothermal Features and by enabling use and development of other geothermal systems and by requiring that the use and development of land provides for protection of the systems with Significant Geothermal Features.

8.1.1.1 Classification of geothermal resources

Geothermal systems within the Bay of Plenty Region are defined using resistivity surveys and drilling information. Systems are then classified into management groups in the RPS according to:

- System temperature – high (>70°C) or low (>30°C <70°C)
- Existing Use – whether the system has large scale existing land development on the system or significant existing extractive use of the system
- Significant Geothermal Features (SGF) – whether SGFs are present in the system
- Vulnerability of SGFs – vulnerability to extractive use
- Research systems – a temporary classification, used when insufficient information is known about the system and a precautionary approach is adopted before it is reclassified.

Systems classified in Group 1 (Table 8-1) are protected systems being of high temperature, no existing extractive use, numerous SGFs with high to moderate vulnerability from extraction where there is considered no potential for extractive use. The other end of the scale is Group 5 (Table 8-1) which are low temperature systems with varying levels of existing extractive use, few or no SGFs and some potential for development of extractive use (heat or fluid).

Table 8-1 is a summary of the classification of geothermal fields in the Bay of Plenty Region under the Bay of Plenty Regional Natural Resources Plan. These are illustrated on Figure 8-2 below.

Table 8-1 Classification of geothermal fields in the Bay of Plenty Region

Geothermal Management Group 1 **(Protected)**	**Geothermal Management Group 2** **(Rotorua)**	**Geothermal Management Group 3** **(Conditional Development)**	**Geothermal Management Group 4** **(Development Systems)**	**Geothermal Management Group 5** **(Low temperature)**
1. Waimangu/ Rotomahana/ Tarawera	4. Rotorua	5. Tikitere/ Ruahine	9. Kawerau	12. Mayor Island (Tuhua)
2. Whakaari (White Island)		6. Taheke	10. Lake Rotoiti	13. Tauranga/ Mt Maunganui
3. Motohora Island (Whale Island)		7. Rotokawa/ Mokoia Island	11. Rotoma/ Puhipuhi	14. Papamoa/ Maketu
		8. Rotoma/ Tikorangi		15. Matata (prospect)
				16. Awakeri
				17. Pukehina
				18. Manaohau

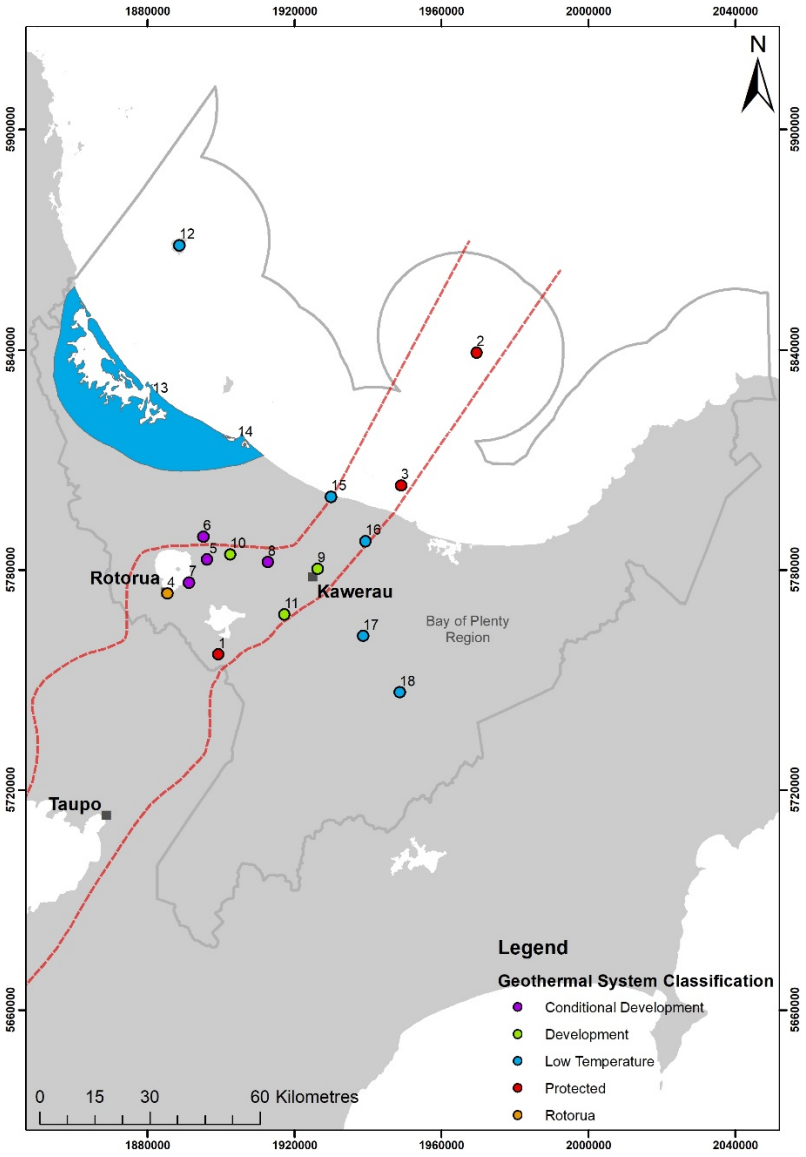

Figure 8-2 Bay of Plenty Geothermal System Classifications. Field names are referenced in Table 8-1

8.1.2 Regional Plans

The Bay of Plenty region has had a standalone Regional Plan for the Rotorua Geothermal area since July 1999, reflecting the importance of geothermal resources to the city/region. Work is currently underway on combining regional planning documents into a single Bay of Plenty Regional Natural Resources Plan (RNRP). There are currently four regional plans that apply to the management of geothermal resources in the region:

- Regional Natural Resources Plan – applying to geothermal resources outside of Rotorua and Kawerau.
- Regional Coastal Environment Plan – applying to the abstraction of geothermal water, heat or energy on the seaward side of mean high water spring (MHWS).

- Rotorua Geothermal Regional Plan – applying to Rotorua to recognise the unique nature of these geothermal resources
- Tarawera River Catchment Plan – applying to the catchment of Tarawera River, and primarily to manage water quantity and water quality in the river catchment near Kawerau township. The Plan also manages activities within geothermal systems in the Tarawera River catchment, being the Kawerau Geothermal System.

The map in Figure 8-3 below indicates the extent of application of the Rotorua Geothermal Regional Plan.

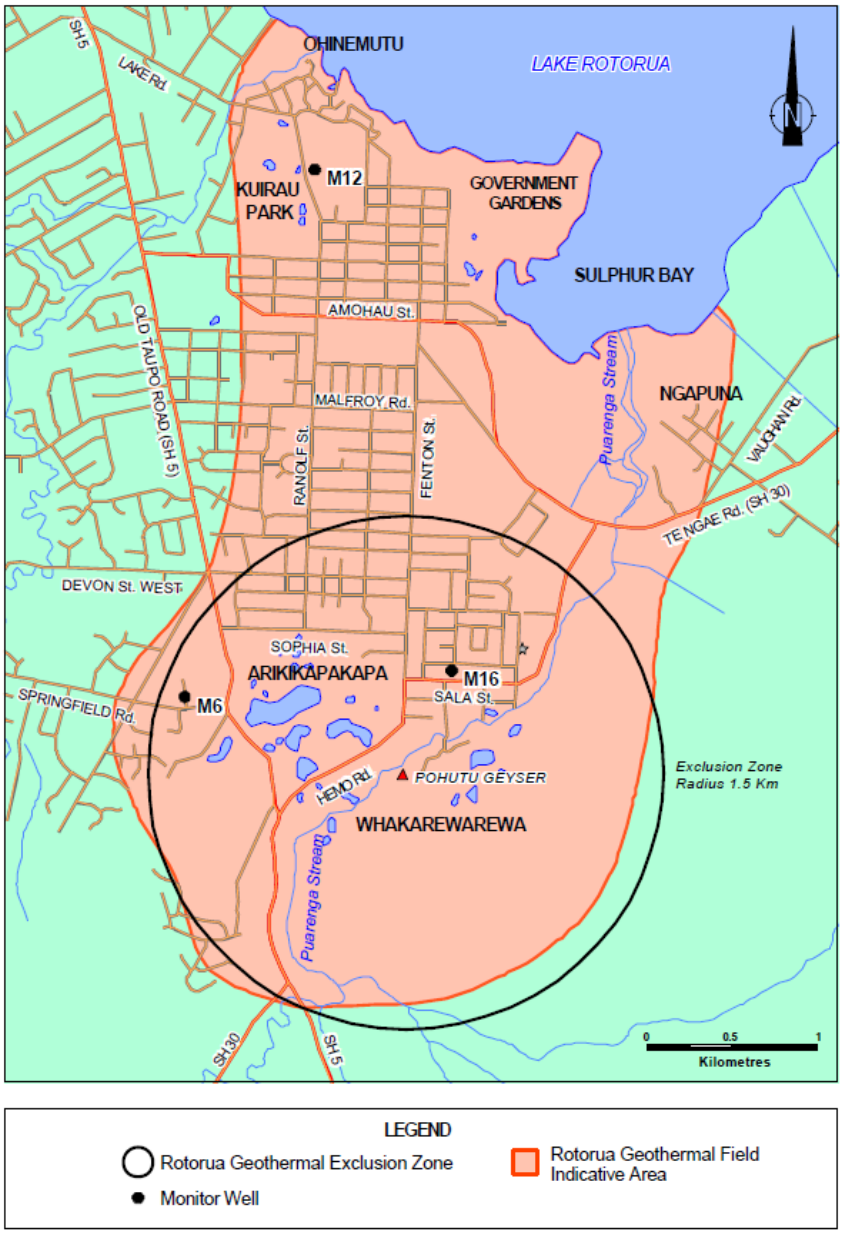

Figure 8-3 Extent of application of the Rotorua Geothermal Regional Plan

The Rotorua Geothermal Exclusion Zone excludes the installation of down hole heat exchange systems where geothermal fluid temperatures are 100°C and above due to the detrimental pressure changes in two phase (i.e. steam/water) zones.

8.1.3 Kawerau Geothermal System Management Plan

The purpose of the system management plan (SMP) for the Kawerau Geothermal system is to ensure the system is managed in an integrated and sustainable manner in accordance with the requirements of the RMA and the RPS.

The Bay of Plenty Regional Policy Statement (RPS) requires the preparation of an SMP for the Kawerau Geothermal System as a key part of the way in which BOPRC intends to manage the Kawerau Geothermal System.

As identified in Table 8-2 above, the Kawerau system is classified as a Development System (Group 4) and the focus of the SMP is to guide how the geothermal resource is managed to meet the needs of current and future generations.

The parties to the SMP are the BOPRC and the four parties that currently hold resource consents which authorise the take of more than 1,000 tonnes per day of geothermal water from the Kawerau System:

- Mercury NZ – electricity generator from a 100 MWe geothermal power station (commissioned 2008). Geothermal fluid is reinjected following its use.
- Ngāti Tūwharetoa Geothermal Assets Ltd – wholesale supplier of geothermal energy and fluid, supporting Kawerau industrial activities.
- Geothermal Developments Ltd – operates a 9 MWe binary geothermal power plant. Geothermal fluid is reinjected following its use.
- Te Ahi o Māui Partnership – generates 25 MWe Te Ahi o Maui Geothermal Power Plant.

8.2 Waikato Regional Council

8.2.1 Regional Policy Statement

The Waikato Regional Policy Statement includes specific objectives and policies in relation to geothermal systems and significant geothermal features. While significant resource management issues specific to geothermal resources are identified, there are a number of relevant resource management issues including:

- The declining quality and quantity of natural and physical resources and the impacts of this on intrinsic values and ecosystem services.

- Increasing demand for energy, particularly from renewable sources and the need to improve energy use and for new energy projects and infrastructure.
- Recognition that the built environment, including infrastructure, has the potential to have effects on the sustainable management of natural and physical resources.
- Degradation of the health and wellbeing of the Waikato and Waipā Rivers.

Objectives in the RPS seek to ensure that natural and physical resources are managed in a sustainable way that recognises their inter-relationships and that ensure that energy use is managed, and electricity generation is developed and operated efficiently, recognising increasing energy demands and reducing the demands on fossil fuels over time.

Objective 3.17 is specifically relevant to the management of regional geothermal resources and requires:

- ensuring integrated management of geothermal systems;
- allocating some of the geothermal resource for take, use and discharge in a way that enables current energy needs and the reasonably foreseeable energy needs of future generations to be met, while avoiding, remedying or mitigating significant adverse effects on the Regional Geothermal Resource; and
- protecting some characteristics of the Regional Geothermal Resource from significant adverse effects.

8.2.1.1 Classification of Geothermal Systems

Geothermal systems in the Waikato are defined as "an individual body of geothermal energy and water not believed to be hydrologically connected to any other…".

The RPS requires Regional Plans to classify geothermal systems as one of the following:

- Development Geothermal Systems – large systems where the development of geothermal resources is enabled.
- Limited Development Geothermal Systems – large systems with significant geothermal features that could be adversely affected by large-scale development but where smaller scale uses could be appropriate.
- Protected Geothermal Systems – large geothermal systems where there is the potential for significant geothermal features to be affected by extraction activities.
- Research Geothermal Systems – generally where there is a lack of information to define them as any other category of system.
- Small Geothermal Systems – not connected to a large geothermal system and does not have a temperature of >100°C or does not have a volume of greater than 10km^3.

8.2.2 Regional Plans

Module 7 of the Waikato Regional Plan (Operative 2007) relates specifically to geothermal resources. The Plan classifies existing geothermal systems according to the descriptions provided in the RPS. These are summarised in Table 8-2 and illustrated on Figure 8-4 below. The plan also identifies the location of significant geothermal features (SGF) within geothermal systems and the values of these features. The geothermal systems and SGFs are included on maps within the Plan also.

Table 8-2 Classification of geothermal fields in the Waikato Region

Development Geothermal Systems	Limited Development Geothermal Systems	Protected Geothermal System	Research Geothermal Systems	Small Geothermal Systems
1. Horohoro	8. Atiamuri	10. Horomatangi	15. Reporoa	None identified
2. Mangakino	9. Tokaanu-Waihi-Hipaua	11. Orakei Korako	Large systems undiscovered at 12 August 2003	
3. Mokai		12. Te Kopia		
4. Ngatamariki		13. Tongariro		
5. Ohaaki		14. Waikite - Waiotapu - Waimangu		
6. Rotokawa				
7. Wairakei-Tauhara				

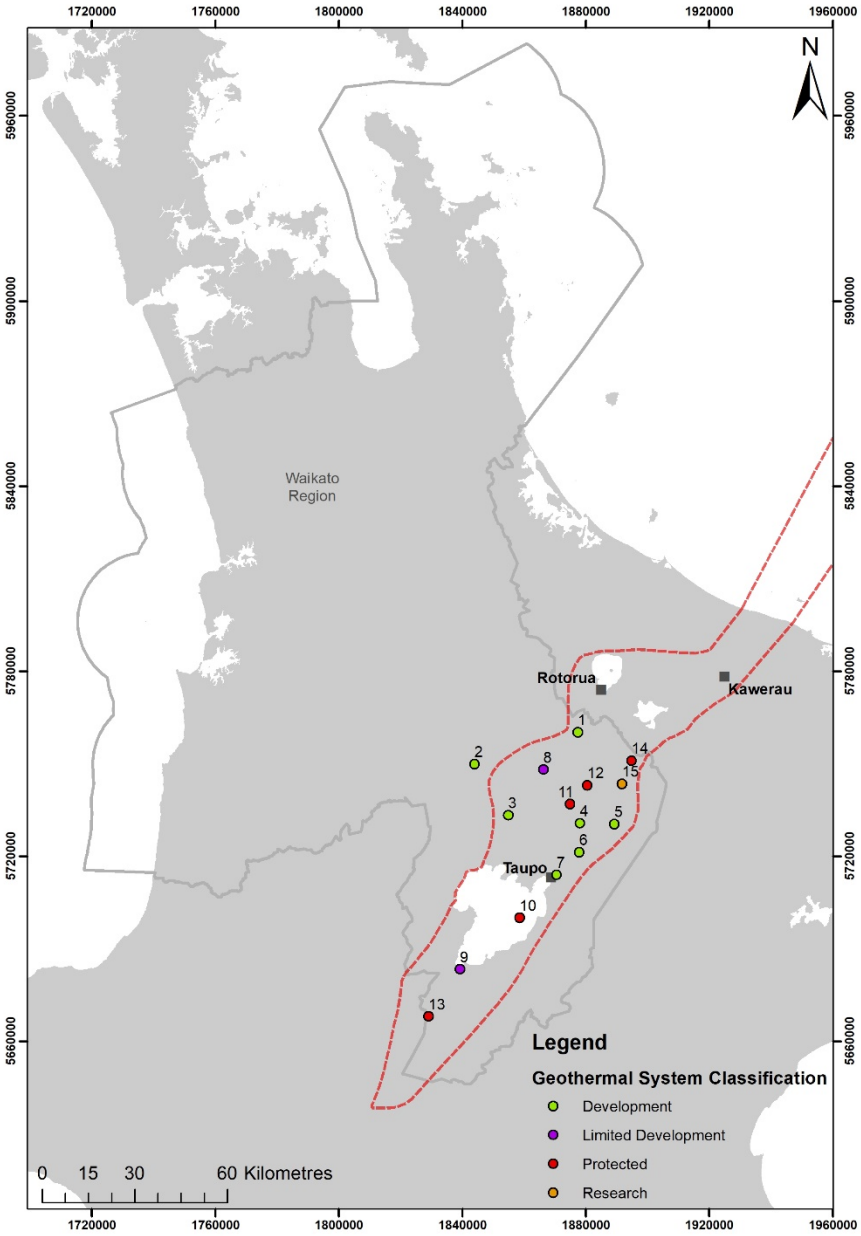

Figure 8-4 Waikato Regional Geothermal Field Classifications. Field names are referenced in Table 8-2

The Regional Plan also includes flow charts which summarises the rules for takes and discharges in geothermal systems to guide plan users when determining the status of their geothermal take and discharge activities.

8.3 Northland Regional Council

8.3.1 Regional Policy Statement

The Northland RPS (Operative May 2016) includes references to geothermal resources in provisions relating to:

- Economic potential and social wellbeing and recognition that the generation and supply of energy is critical for the community and economy and has improved significantly with the geothermal generation from Ngāwhā.
- Securing of energy supply recognising the renewable energy sources in the region.
- Renewable energy including recognition of the Ngāwhā geothermal power station.
- Regionally significant infrastructure including the Ngāwhā geothermal power station.
- Areas of significant indigenous vegetation and significant habitats of indigenous fauna (Appendix 5) acknowledging the ecological context including that of geothermal sites.

8.3.2 Regional Plan

The Northland Regional Plan is currently undergoing a review, and at the time of writing, is with the Environment Court for the resolution of appeals. An appeals version of the Proposed Plan was released on 29 July 2019 and this version is discussed in this report.

Policy D.2.10 relating to renewable energy recognises high temperature geothermal resources at Ngāwhā and the need to have regard to the effective generation of energy from geothermal resources and the need to include the consumptive use of geothermal heat and pressure when considering activities associated with the generation of renewable energy resources.

The framework in the regional plan for the management of geothermal resources is more limited compared with the approaches taken in the Waikato and Bay of Plenty Regions which reflects the smaller scale of geothermal resources in the region, with a single system and a number of isolated surface expressions.

Effects on geothermal surface features from the following activities are considered through regional plan provisions:

- Stormwater discharges
- Industrial and trade wastewater discharges
- On-site refuse disposal
- Discharges from composting operations
- Earthworks
- Discharges from bores

8.4 Manawatū-Whanganui Regional Council (Horizons)

8.4.1 Regional Policy Statement

There is limited reference to geothermal resources in the RPS for the Manawatū/Whanganui Region, however reference is largely incorporated into provisions relating to renewable energy generation and use. Section 3 of the RPS specifically relates to Infrastructure, Energy, Waste, Hazardous Substances, and Contaminated Land.

This section identifies the following regional resource management issues in relation to energy:

> *Energy conservation and energy efficiency are important but on their own will not be sufficient to meet future energy demands. If consumption of non-renewable energy resources is to be reduced or avoided, there will need to be an increase in the use of renewable energy resources. However, there are functional, operational and technical factors that constrain the location, layout, design and generation potential of renewable energy facilities.*

Objectives are included in the RPS which seek to ensure that there is improvement in the efficiency of energy use and an increase in the use of renewable energy resources within the Region.

8.4.2 Regional Plan

There are no specific provisions which relate to the management and use of geothermal resources in the Region, so any take, use or discharges associated with the management and use of geothermal resources would be addressed through the sections of the Plan focussed on those activities generally.

8.5 Conclusion – current planning framework

Overall, there is a range of methods used to managing the use and development geothermal resources by regional councils in New Zealand. These range from extensive and specific approaches as developed by the Bay of Plenty and Waikato Regional Council's through to no specific provisions, such as the approach used by the Manawatū-Whanganui Regional Council in the One Plan. Logically, the detail of a management regime appears to directly respond to the importance and prominence of geothermal resources and their use in the particular region.

9 Implications for Supercritical

This background information will inform further research work under GNG, which will focus on the future potential development and use of hotter, deeper supercritical geothermal resources and an optimal planning framework to enable this, while achieving sustainable management.

We understand that Supercritical geothermal fluids are likely to be found at a depth of >5 km and at temperatures exceeding 400°C, and that these resources are likely to offer significantly more energy than conventional geothermal fluids found at current depths (~3.5 km) and reservoir temperatures (<350°C).

However, uncertainty remains around the location, scale, and accessibility of Supercritical resources. 'Geothermal: The Next Generation' is a programme designed to address geological, geochemical and technological challenges for Supercritical, unknown in current geothermal use. The team, combining expert geophysicists, geologists, experimental geochemists, modellers and strategic advisors, will investigate New Zealand's supercritical conditions and learn from international experiences.

The research programme will, over its 5-year timeframe (2019-2024):

- define heat transfer mechanisms from magma to surface;
- investigate the composition of supercritical fluids;
- detail interactions between rocks and fluids;
- find the best exploration drilling targets for supercritical fluids;
- map the potential of these resources, and
- translate the science, making information accessible.

This paper will inform future involvement in providing feedback on the reform of the RMA and the new legislation proposed to replace it. Submission(s) on the new legislation will likely focus on how to enable geothermal and Supercritical resource use and development while dealing with the inherent uncertainty and adapting mitigation in response to potential environmental effects.

10 Conclusions

In New Zealand, geothermal fluids are defined as water heated through earth processes to more than 30 degrees Celsius.

Geothermal fluids are treated and managed as water resources, with no ownership rights conferred on any one party. The ownership of land overlying geothermal resources is relevant to determining the right of access for development.

Geothermal energy already makes a substantial contribution to New Zealand's' energy requirements, and there are opportunities to use more geothermal energy directly as the nation transitions to "zero carbon" energy by 2050.

While the current main guiding legislation for the use and development of geothermal resources is the Resource Management Act 1991, a series of regulatory layers apply. Separate legislation also applies to the Exclusive Economic Zone and Continental Shelf, which would be relevant to the development of geothermal resources located beyond the outer limit of the territorial sea (12NM from MHWS), although no current examples of such development exist.

At the time of writing this report, there is little or no national direction under the RMA directly relevant to the use and development of geothermal resources. In practice, this means that the requirements of the RMA as it relates to geothermal development are independently interpreted and implemented at a regional scale by Regional Councils.

The supercritical geothermal resources being considered as part of the GNG research programme are expected to be at temperatures in excess of ~400°C, possibly as hot as 600°C, at 4-7 km depth. These resources may have the potential to contribute significantly to New Zealand's national energy demand in a zero-carbon future.

Is there an opportunity to identify and design a regulatory approach which ensures that these resources are managed in a sustainable and nationally consistent way, while appropriately realising the national benefit these resources could provide?

Analysis on the suitability of New Zealand's current planning framework for managing the potential future use of supercritical geothermal resources is being developed under the GNG research programme. The repeal and replacement of the RMA provides an opportunity to contribute to the development of new legislation to provide an optimal framework for Supercritical geothermal resource use and development through the submission and select committee process.

With proposed legislative changes on the way which are likely to result in changes in the management of natural and physical resources, there are some fundamental aspects that are anticipated to remain including the requirement for achieving sustainability and the need to understand and assess effects on

environment. It is possible that the new legislation will incorporate requirements for a precautionary approach to approval, as is currently included in the EEZ legislation. This will pose future challenges for the use and development of Supercritical resources as there is currently a high degree of uncertainty in relation to where the resources are and whether they are connected to other, shallower geothermal resources.

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12 Appendices

Appendix 1: Glossary

Acronym/Term	Definition
BOP	Bay of Plenty
BOPRC	Bay of Plenty Regional Council
CMA	Coastal Marine Area
Consent Authority	Council's responsible for considering applications for resource consents including territorial authorities (city or district councils) and regional councils.
EPA	Environmental Protection Agency
EEZ	Exclusive Economic Zone
Hapū	subtribe made up of a number of families (whānau). These families sharing descent from a common ancestor.
Iwi	A number of related hapū usually shared adjacent territories. A tribe of people known within a rohe which describes the territory or boundaries.
Kaitaki	Trustee, custodian, guardian
Kōrero	To tell, speak, say
Mana tuku iho	Inherited status
MCA	Marine and Coastal Areas (Takutai Moana) Act
MHWS	Mean High Water Springs
NES	National Environmental Standard
NPS	National Policy Statement
NPSREG	National Policy Statement for Renewable Energy Generation
NZCA	New Zealand Conservation Authority
NZCPS	New Zealand Coastal Policy Statement
NZEECS	New Zealand Energy Efficiency and Conservation Strategy
NZETS	New Zealand Emissions Trading Scheme
NZU	New Zealand Emissions Unit
PCE	Public Conservation Estate
RMA	Resource Management Act
Rohe	Boundary, district, region
RPS	Regional Policy Statement
SGF	Significant Geothermal Feature

Acronym/Term	Definition
SMP	System Management Plan
Tangata whenua	People of the land, indigenous people
Two-phase fluid	is a mixture of a liquid and a gas (steam) in a fluid stream, i.e. two phases present in the fluid.
TVZ	Taupō Volcanic Zone
UEF	Unique Emission Factor
Whakapapa	Genealogy, lineage, decent
Whanau	Family

12.1.1 Key definitions from the RMA

Geothermal energy means energy derived or derivable from and produced within the earth by natural heat phenomena; and includes all geothermal water.

Geothermal water means water heated within the earth by natural phenomena to a temperature of 30 degrees Celsius or more; and includes all steam, water, and water vapour, and every mixture of all or any of them that has been heated by natural phenomena.

Network utility operator means a person who –

(a) Undertakes or proposes to undertake the distribution or transmission by pipeline of natural or manufactured gas, petroleum, biofuel or geothermal energy…

Water -

(a) means water in all its physical forms whether flowing or not and whether over or under the ground:

(b) includes fresh water, coastal water, and geothermal water:

(c) does not include water in any form while in any pipe, tank, or cistern

12.1.2 Key definitions from the Marine and Coastal Areas (Takutai Moana) Act

Common Marine and Coastal Area means the marine and coastal area other than—

(a) specified freehold land located in that area; and

(b) any area that is owned by the Crown and has the status of any of the following kinds:

(i) a conservation area within the meaning of section 2(1) of the Conservation Act 1987:

(ii) a national park within the meaning of section 2 of the National Parks Act 1980:

(iii) a reserve within the meaning of section 2(1) of the Reserves Act 1977; and

(c) the bed of Te Whaanga Lagoon in the Chatham Islands

Customary Marine Title means the customary interests—

(a) established by an applicant group in accordance with subpart 3 of Part 3; and

(b) recognised by—

(i) a customary marine title order; or

(ii) an agreement

Protected Customary Right means an activity, use, or practice—

(a) established by an applicant group in accordance with subpart 2 of Part 3; and

(b) recognised by—

(i) a protected customary rights order; or

(ii) an agreement

12.1.3 Key Definitions from the Climate Change Response Act

Carbon Dioxide Equivalent, in relation to a gas in Annex A of the Protocol, means the amount, in tonnes, of carbon dioxide that would produce the same global warming as the amount of that gas, calculated by multiplying the tonnes of that gas by its global warming potential (as determined under Article 5.3 of the Protocol, as if the commitment period were binding on New Zealand)

Emissions means emissions of greenhouse gases and in relation to activities, including using geothermal fluid for the purpose of generating electricity of heat (initial use only) means *carbon dioxide equivalent emissions of greenhouse gases from the activity.*

Greenhouse gas means a gas in the earth's atmosphere that strongly absorbs and re-emits infrared radiation, and includes indirect greenhouse gases, but does not include a gas that is covered by the Montreal Protocol on Substances that Deplete the Ozone Layer.

Stationary energy is defined as using geothermal fluid for the purpose of generating electricity or industrial heat (initial use only).

12.1.4 Key definitions from the Crown Minerals Act

Mineral means a naturally occurring inorganic substance beneath or at the surface of the earth, whether or not under water; and includes all metallic minerals, non-metallic minerals, fuel minerals, precious stones, industrial rocks and building stones, and a prescribed substance within the meaning of the Atomic Energy Act 1945.

Prospecting

(a) means any activity undertaken for the purpose of identifying land likely to contain mineral deposits or occurrences; and

(b) includes the following activities:

(i) geological, geochemical, and geophysical surveying:

(ii) aerial surveying:

(iii) taking samples by hand or hand held methods:

(iv) taking small samples offshore by low-impact mechanical methods

Exploration *means any activity undertaken for the purpose of identifying mineral deposits or occurrences and evaluating the feasibility of mining particular deposits or occurrences of 1 or more minerals; and includes any drilling, dredging, or excavations (whether surface or subsurface) that are reasonably necessary to determine the nature and size of a mineral deposit or occurrence; and to explore has a corresponding meaning*

Mining

(a) means to take, win, or extract, by whatever means,—

(i) a mineral existing in its natural state in land; or

(ii) a chemical substance from a mineral existing in its natural state in land; and

(b) includes—

(i) the injection of petroleum into an underground gas storage facility; and

(ii) the extraction of petroleum from an underground gas storage facility; but

(c) does not include prospecting or exploration for a mineral or chemical substance referred to in paragraph

12.1.5 Key definitions Rotorua City Geothermal Energy Empowering Act 1967

Geothermal energy *means energy derived or derivable from and produced within the earth by natural heat phenomenon; and includes all steam, water, and water vapour, and every mixture of all or any of them that has been heated by geothermal energy, and every kind of matter derived from a bore and for the time being with or in any such steam, water, water vapour, or mixture*

Geothermal works *means and includes any work or works established or constructed, whether finally completed or not, for the investigation, development, supply, and utilisation of geothermal energy, the prevention or disposal of waste, the disposal of water, steam or any other product arising from the development, reticulation, supply, or utilisation of geothermal energy, and any work or works from time to time deemed necessary by the Council for the safe and efficient control of the supply and utilisation of geothermal energy; and also includes all plant, apparatus, appliances, and materials comprising part of any geothermal work or works.*

Appendix 2: Introductory Guides

GNS Science has produced four fact sheets on geothermal resources that provide introductory information on geothermal energy and its uses including the use of ambient ground and water resources through heat pump technology. They can also be downloaded along with other educational material, including case studies, from the GNS Science website.

Geothermal: The Earth's Energy

Geothermal Energy to Electricity

Using Geothermal Energy Directly

Geothermal Heat Pumps for Heating and Cooling

Appendix 3: New Zealand Energy Use and Greenhouse Gas Emissions

The Ministry of Business, Innovation and Employment (MBIE) collects and shares data on the total primary energy, consumed energy, electricity generation and equivalent carbon emissions for New Zealand.

Total Primary Energy Sources

In 2019, New Zealand's total primary energy supply amounted to ~903 PJ. This is dominated by 60% carbon-sourced fuels (oil 32.8%, natural gas 20.5% and coal 7.1%), and ~40% renewable (made up of geothermal 21.7%, hydro 10.2%, wood 6.2%, wind 0.9%, biogas 0.4%, Solar 0.1% and liquid biofuels 0.02%) (Figure 11-1) (MBIE, 2019).

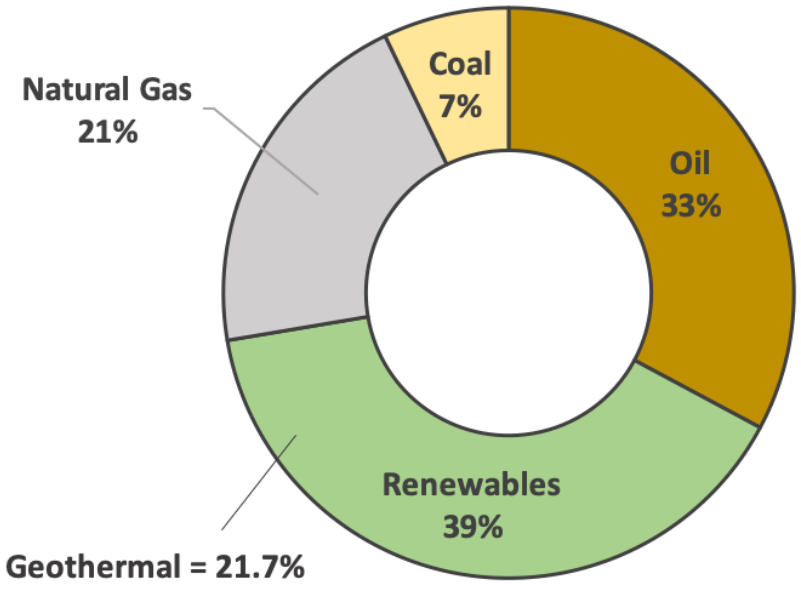

Figure 12-1 2019 renewable and carbon-based primary energy sources in New Zealand (MBIE, 2019)

Consumed Energy

In 2019, New Zealand's total energy consumed was ~590 PJ (Figure 11-2). This is dominated by consumption of ~70% carbon-based fuels (oil 47%, natural gas 13%, coal 4.8% and carbon-based electricity 4.3%), and ~30% renewable energy sources (electricity 20.3%, other 10.2%). The 'Renewable Other' category includes wood, biogas, solar and geothermal direct heat supplies.

Geothermal accounts for about 5.6% of the total consumed energy, of which 4.3% is from geothermally produced electricity (~ 25PJ), and 1.4% is from direct geothermal energy use (~ 8PJ).

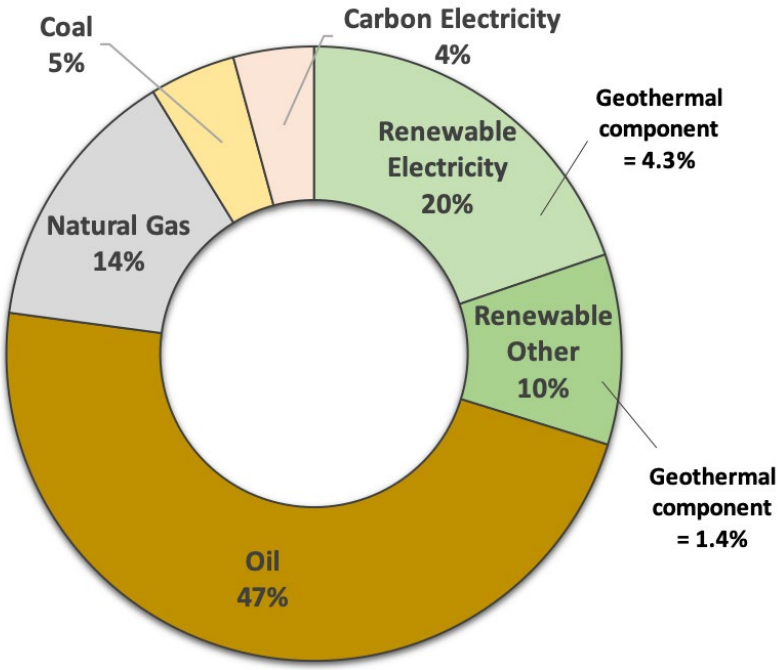

Figure 12-2 Percentage consumed energy broken down by fuel type (MBIE, 2019).

Electricity Generation

Electricity in New Zealand is predominantly generated from renewable sources. Hydro, geothermal and natural gas are the top three energy sources contributing to electricity production (Figure 11-3). In 2019, 156 PJ of electricity was generated, with 82.4% of that produced from renewable sources (hydro 58%, geothermal 17%, wind 5% and other renewable ~2%) and 18% from carbon-based sources (12.6% gas, 5% coal and oil).

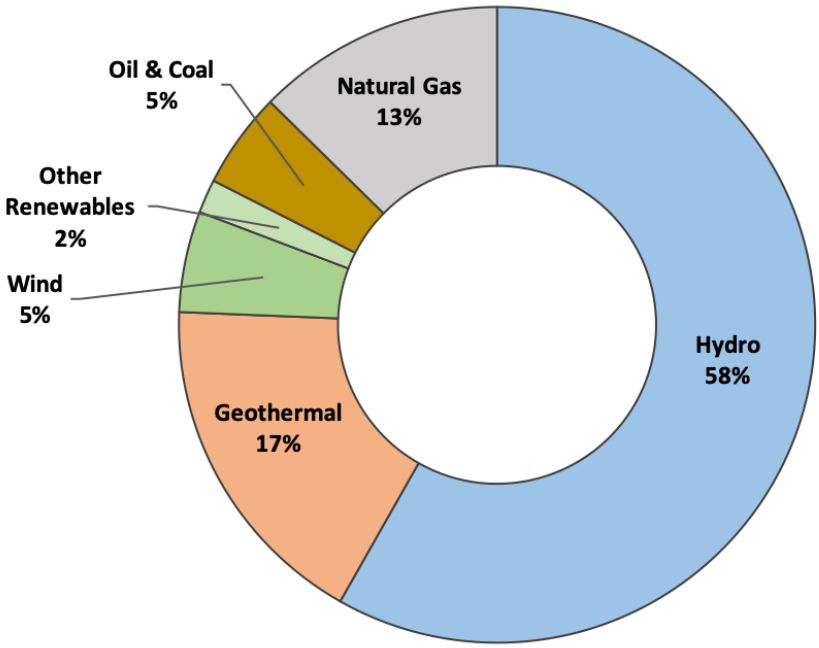

Figure 12-3 Renewable and carbon electricity percentages for 2018 (MBIE, 2018).

Greenhouse Gas - Carbon Equivalent Emissions

The 2018 recorded greenhouse gas equivalent total carbon emissions from the energy sector (from both supply and use) amounted to ~32,000 ktonnes $CO_{2\text{-}e}$ (MBIE, 2018), with international air travel and shipping amounting to ~4,900 ktonnes $CO_{2\text{-}e}$ in additional emissions. A broad sub-sector breakdown of carbon emissions from energy supply and use in percentage terms is shown in Figure 11-3.

The geothermal contribution to greenhouse gas emissions amounted to 730.8 ktonnes in 2018. It is included in the fugitive (non-combustion) category in Figure 11-4, because geothermal emissions are not associated with combustion processes.

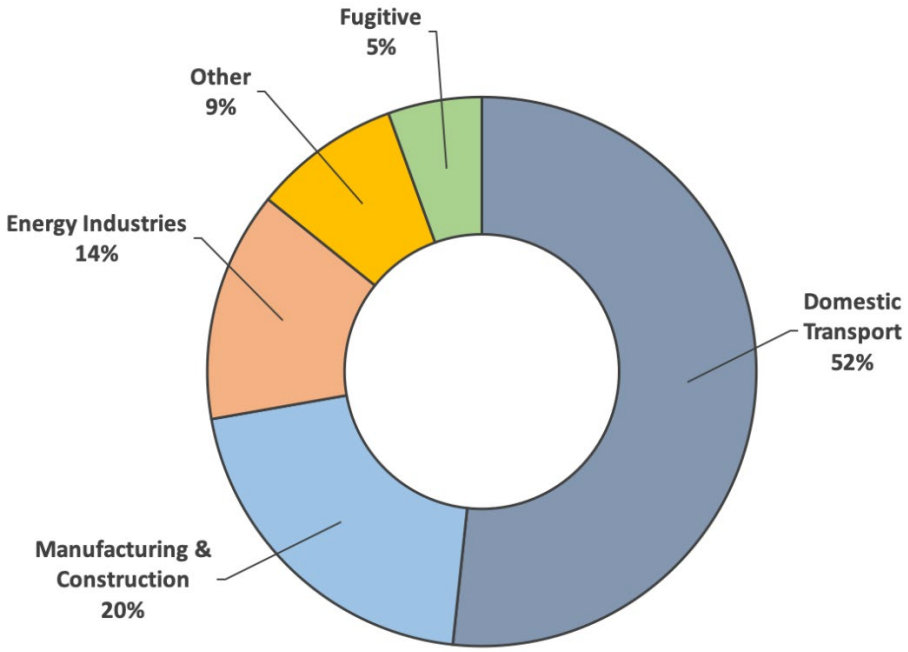

Figure 12-4 Sub sector percentages of the 2018 energy sector $CO_{2\text{-}e}$ emissions; total emissions was 32,104.68 ktonnes (MBIE, 2018).

Mclean and Richardson (2019) provide data on greenhouse gas emissions from New Zealand's geothermal power plants since 2010. The annual emissions from geothermal electricity facilities amount to ~77% of the recorded total geothermal emissions for 2018, Mclean and Richardson (2019) reported~560 ktonnes $CO_{2\text{-}e}$.

Appendix 4: Life Cycle Assessment of Green House Gas Emissions by Generation Type

A comprehensive through life emissions of a facility should include emissions associated with the total operation, including the materials of construction, the construction process, operational, maintenance activity and decommissioning emissions.

Figure 11-5 was prepared by the New Zealand Geothermal Association (NZGA 2021) and presented in the Association's submission to the Climate Change Commission Draft Advice to Government (CCC 2021).

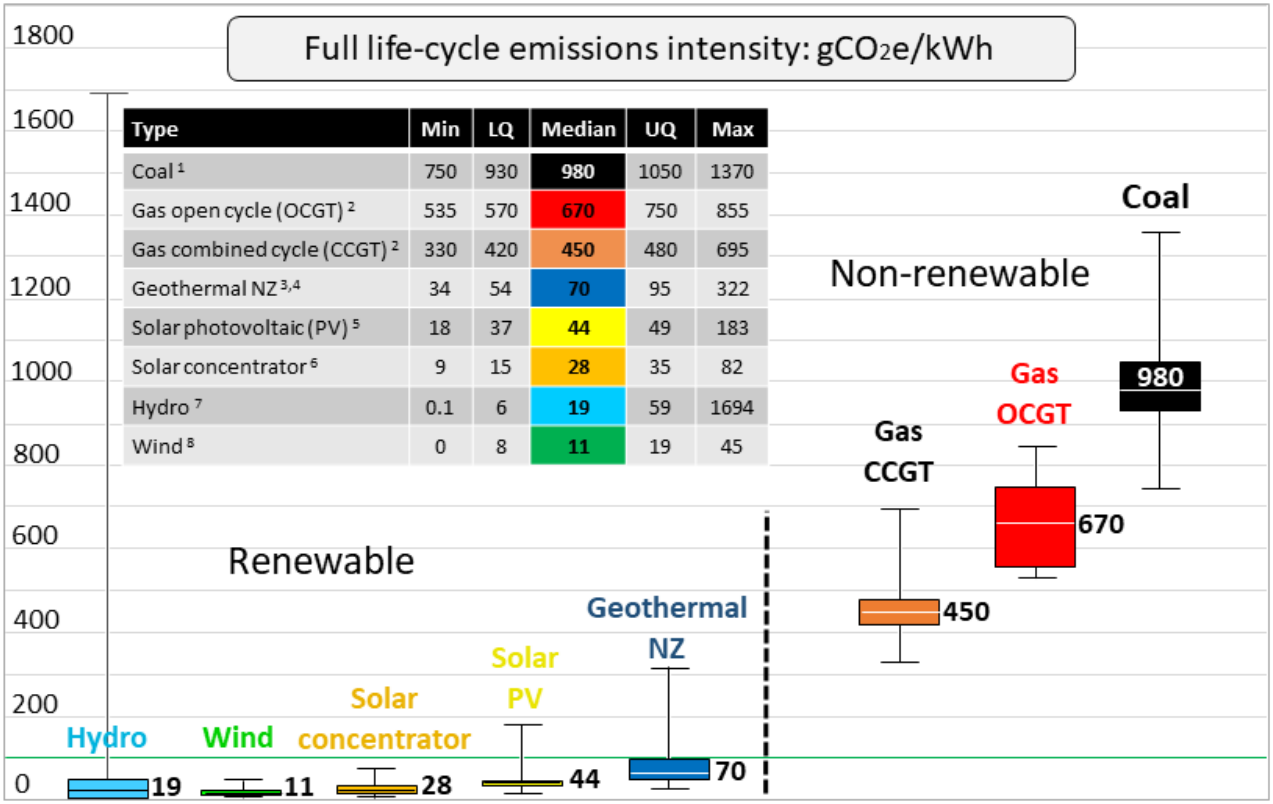

Figure 11-5 Lifecycle emissions intensity gCO2e/kwh for different types of electricity generation facilities (NZGA 2021, for the superscript references in the figure key refer page 10 NZGA 2021)

Statistical comparison for life cycle emissions should focus on the median statistic rather than the outliers.

All renewables (to the left of the vertical black dashed line in Figure 11-5) have median life cycle emissions intensities an order of magnitude lower than from fossil fuel sources.

Geothermal NZ has the highest median emissions intensity of the renewables plotted, followed by solar PV, concentrating solar, hydro and then wind with the lowest.

The New Zealand ETS, discussed in Section 7.1.1, applies to operational Green House Gas emissions only.

Appendix 5: Document links

Resource Management Act 1991	http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html
Conservation Act 1987	http://www.legislation.govt.nz/act/public/1987/0065/latest/DLM103610.html
Marine and Coastal Area (Takutai Moana) Act 2011	http://www.legislation.govt.nz/act/public/2011/0003/latest/DLM3213131.html
Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012	http://www.legislation.govt.nz/act/public/2012/0072/latest/DLM3955428.html
Energy Efficiency and Conservation Act 2000	http://www.legislation.govt.nz/act/public/2000/0014/latest/DLM54948.html
Climate Change Response Act 2002	http://www.legislation.govt.nz/act/public/2002/0040/latest/DLM158584.html
Rotorua City Geothermal Energy Empowering Act 1967	http://legislation.govt.nz/act/local/1967/0002/4.0/DLM64624.html
Crown Minerals Act 1991	http://www.legislation.govt.nz/act/public/1991/0070/latest/DLM242536.html
National Policy Statements	https://www.mfe.govt.nz/rma/rma-legislative-tools/national-policy-statements
National environmental Standards	https://www.mfe.govt.nz/rma/rma-legislative-tools/national-environmental-standards
National Planning Standards	https://www.mfe.govt.nz/rma/national-direction/national-planning-standards
New Zealand Coastal Policy Statement	https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/nz-coastal-policy-statement-2010.pdf
Conservation General Policy	https://www.doc.govt.nz/globalassets/documents/about-doc/role/policies-and-plans/conservation-general-policy.pdf
Conservation Management Strategies	https://www.doc.govt.nz/about-us/our-policies-and-plans/statutory-plans/conservation-management-strategies/
National Park Management Plans	https://www.doc.govt.nz/about-us/our-policies-and-plans/statutory-plans/national-park-management-plans/
Conservation Management Plans	https://www.doc.govt.nz/about-us/our-policies-and-plans/statutory-plans/conservation-management-plans/

Bay of Plenty Regional Policy Statement	https://www.boprc.govt.nz/your-council/plans-and-policies/policies/regional-policy-statement
Bay of Plenty Regional Natural Resources Plan	https://www.boprc.govt.nz/your-council/plans-and-policies/plans/regional-plans/regional-natural-resources-plan
Rotorua Geothermal Regional Plan	https://www.boprc.govt.nz/your-council/plans-and-policies/plans/regional-plans/rotorua-geothermal-regional-plan
Waikato Regional Policy Statement	https://www.waikatoregion.govt.nz/council/policy-and-plans/regional-policy-statement/
Waikato Regional Plan	https://www.waikatoregion.govt.nz/council/policy-and-plans/rules-and-regulation/regional-plan/
Northland Regional Policy Statement	https://www.nrc.govt.nz/your-council/about-us/council-projects/new-regional-policy-statement/
Northland Regional Plan	https://www.nrc.govt.nz/your-council/about-us/council-projects/new-regional-plan/
Manawatū-Whanganui combined Regional Policy Statement & Regional Plan	http://www.horizons.govt.nz/publications-feedback/one-plan