August 3, 2021

Attn: Committee Secretariat
Environment Committee
Parliament Buildings
Wellington
E: en@parliament.govt.nz

Submission on *Natural and Built Environments Act* Exposure Draft (July 2021)

This document is submitted on behalf of the New Zealand Geothermal Association by Paul Siratovich (President).

New Zealand Geothermal Association (NZGA)

1. The NZGA, incorporated in 1992, is a non-political, non-governmental and not-for-profit organisation, with a focus on fostering a sustainable future for Aotearoa New Zealand through use, development and protection of geothermal resources. The NZGA is an affiliated member of the International Geothermal Association and the Royal Society of New Zealand. The NZGA connects with global geothermal communities and is well positioned to positively influence geothermal initiatives on the international stage.

2. NZGA membership comprises ca. 400 individuals, as well as corporate members, representing geothermal electricity generators, research organisations, regional councils, engineering consultants, technology companies, planning consultants and Māori trusts. This diverse and skilled network of people work and live with Aotearoa's geothermal resources.

3. This submission has been prepared by members of the New Zealand geothermal community. The submission was reviewed by a reference group including experienced practitioners in the consenting of geothermal projects (including scientists, engineers, planners, lawyers and others). This submission was approved for release by the NZGA executive board.

The Case for Enabling Renewable Geothermal Energy in Transitioning to a Low-Emissions Economy

4. Our challenge as a nation is to ensure that we maximise all of Aotearoa New Zealand's renewable energy resources during the transition to a low-carbon future. This submission is prepared from a viewpoint that Aotearoa New Zealand's geothermal energy resources are critical to our way of life, and that our legacy of low-carbon geothermal energy use gives the nation a competitive advantage in decarbonising its energy sector and diverse economy, created by multiple businesses.

5. Geothermal[1] is a vibrant, proven, indigenous renewable resource, which enables other industries to thrive and regions to grow. The geothermal community seeks to ensure that reform of the Resource Management Act, not only allows, but *enables* geothermal development.

6. Aotearoa New Zealand's geothermal resources are widely used to generate low-carbon electricity, and geothermal heat is used directly to support residential, commercial and industrial scale uses (from tourism, to recreation, and industrial heating).

7. A detailed case outlining the advantages of geothermal energy use can be found in the Appendix. In brief, the key advantages for Aotearoa New Zealand are:

    a. Geothermal investment will accelerate decarbonisation

    b. Geothermal resources are the only low-carbon baseload electricity solution with significant growth potential

    c. Geothermal developments have been the single biggest contributors to reduction of fossil-fuel fired generation in the last two decades

    d. Geothermal is a low-carbon industrial process heat solution that enables other industries to thrive

    e. Geothermal enables Māori socio-economic development

    f. Geothermal energy use catalyses regional growth

    g. Geothermal provides innovative commercial opportunities

    h. Geothermal is a New Zealand icon and legacy, on a global stage

Part A: General Position on Natural and Built Environments Act ("NBA") Exposure Draft

Overall broad judgement: balancing of environmental benefits and effects to transition to a low-emissions Aotearoa New Zealand

8. In the late 1940's / 50's, well before the introduction of the Resource Management Act ("RMA"), geothermal development for nationwide power supply was undertaken, which required bold government decision making and leadership. An absence of certainty at this time did not prevent

[1] The reference to "Geothermal Resources" throughout this submission is a term that is used to describe both low enthalpy resources (>30°C), high-enthalpy conventional geothermal resources (<~3.5 km deep with reservoir temperatures <350°C), and potential (but not yet proven) supercritical geothermal resources (>5 km, >400°C).

decisions being made about tapping into geothermal resources that now support about 17% of the electricity generated in Aotearoa New Zealand.

9. Since then, planning instruments, developed under the RMA, have provided for both heat and electricity geothermal developments to proceed in the Waikato, Bay of Plenty and Northland Regions, with direct use[2] development elsewhere. As more has been learned about the effects of geothermal development over the years, the regulatory and development approaches have been refined, adapted and improved.

10. The current approach applied to RMA decision-making is based on the broad principles of sustainable management (defined in section 5). This is supported by a hierarchy of matters of national significance (in section 6) that provide something in the nature of environmental bottom lines, other matters of significance (in section 7) that are required to be given particular regard, and the principles of the Treaty, recognising the relevance of Te Tiriti o Waitangi to decisions about use, development and protection of natural resources.

11. In relation to renewable energy, there is specific and direct reference in section 7 of the RMA requiring that, in achieving the sustainable management purpose of the RMA, all persons exercising functions and powers are to have particular regard to "(ba) the efficiency of the end use of energy... (i) the effects of climate change [and] (j) the benefits to be derived from the use and development of renewable energy"[3].

12. The NZGA is confident that there is much more that geothermal can contribute to New Zealand's renewable energy and carbon goals, with further exploration and development of existing known resources, as well as the potential for deeper, hotter supercritical resources, particularly within the Taupō Volcanic Zone. To enable future exploration, testing, understanding and sustainable utilisation of geothermal resources, the NBA needs to directly provide for a consideration of regional and national benefits of renewable energy use alongside a consideration of the actual and potential environmental effects of geothermal energy projects.

13. All geothermal developments involve uncertainty, including new developments *and* those that are currently consented and operational. Uncertainties include what might be encountered, whether a well will produce geothermal water and energy, how much and how that might interact with a number of the other elements that make up a geothermal system, and how the system will respond to

[2]Direct use refers to the use of geothermal heat energy in applications other than the generation of electricity. Most processes which need the input of heat can successfully use geothermal energy directly, instead of, or as a supplement to, electricity and/or fossil fuels. Examples include bathing, heating glasshouses and timber drying.
[3]Modified from - Palmer & Grinlinton, Developments in Renewable Energy Law and Policy in NZ, 2014, Jnl of Energy and Natural Law

utilisation. This uncertainty requires geothermal experts to continually monitor, study, review and improve reservoir development strategies.

14. The Parliamentary Paper on the Exposure Draft of the NBA 2021 outlines, at para 87 that "The system needs to recognise and encourage synergies between development and environmental protection. For example, more renewable electricity generation requires new infrastructure such as wind farms". However, the NZGA is not confident that this balance is currently being achieved in the NBA exposure draft as released.

15. The purpose of the NBA is focussed on the protection and enhancement of the environment, and on use of the environment in a way that supports the well-being of present generations, without compromising the well-being of future generations. Yet, the direction through the adoption of a precautionary approach, and setting environmental limits and describing environmental outcomes across the entire range of natural resources, are focussed much more on the environmental protection aspect of this purpose, and less on the ability to use and develop resources in a sustainable way. The NBA exposure draft currently lacks the ability to balance adverse effects with the inherent benefits of the sustainable and efficient use and development of natural and physical resources.

16. **Relief sought**: The NZGA seek that the NBA focus environmental limits and environmental protection on aspects of the environment that are of national or regional importance, and make specific provision for consideration of the benefits of sustainable resource use in meeting national objectives, including, but not limited to, the country's carbon goals, in decisions made under the NBA.

Use of the precautionary approach in relation to geothermal resource use and development lacks certainty

17. Geothermal energy has the potential to make a significant contribution to New Zealand's energy requirements, either through electricity generation or, with even higher levels of efficiency, as a direct source of heat. Geothermal energy is derived from the heat in the earth's core and from radioactive decay within its mantle. At high temperatures and pressures within the mantle, mantle rocks melt forming magma. Geothermal fluids carry this heat closer to the surface where it can be utilised as an energy source.[4]

18. Geothermal systems occur in many parts of Aotearoa New Zealand. High temperature geothermal fields are principally located in the Taupō Volcanic Zone (in the central North Island), with another high temperature field at Ngawha in Northland. Moderate to low, and very low, temperature systems are more widely scattered.

[4] https://nzgeothermal.org.nz/geo_systems/

19. 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 1) (MBIE[5], 2019). These figures confirm the significant existing contribution of geothermal to New Zealand's energy supply.

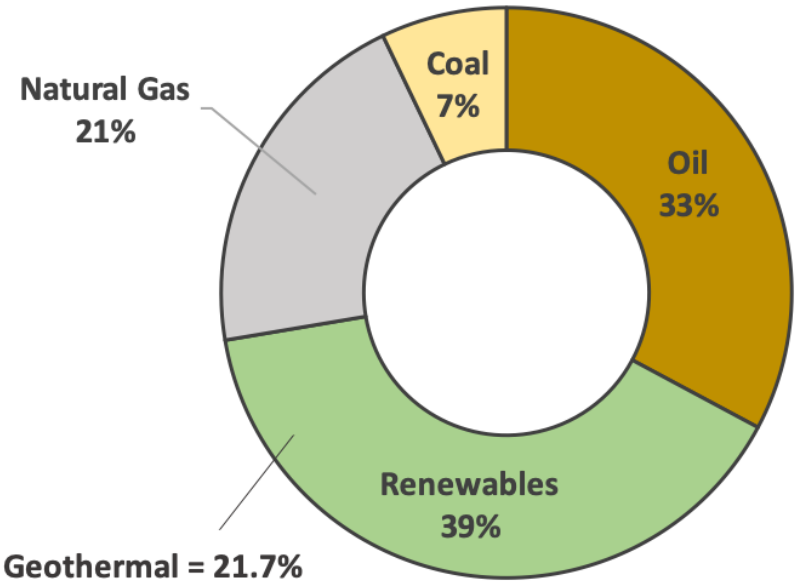

Figure 1: 2019 renewable and carbon-based primary energy sources in New Zealand (MBIE, 2019[5])

20. The nature of geothermal resources means that there is greater complexity and uncertainty associated with them than other renewable energy sources. However, geothermal is also the only renewable energy source which is not reliant on weather or climatic conditions to function and is able to generate heat and energy 24 hours a day, 7 days a week. As a result, geothermal energy resources play an important role in New Zealand's energy future; geothermal energy is always available and nearly always on.

21. Due to the variability in the characteristics of geothermal systems, and the challenges with accessing subsurface information about them, there is inherent uncertainty associated with the use and development of these resources. Resource development requires sequential reduction of uncertainty. This uncertainty requires that the NBA provide flexibility to facilitate exploration and as a result, increase knowledge and understanding of geothermal resources, and to support an appropriate regulatory regime for geothermal development projects.

[5] https://www.mbie.govt.nz/assets/Data-Files/Energy/energy-balance-tables.xlsx

22. A regulatory approach that provides for operation, research and development, within reasonable defined limits, rather than a precautionary approach is needed. A more nuanced/balanced approach is required to enable exploration, research, and testing of geothermal resources (including suitable definitions). This is to acknowledge the vital role of exploration and testing of these resources and to understand available resources and, in turn, the potential effects of their use and development on the environment.

23. New Zealand's current approach to geothermal resource use and development is internationally recognised. Our global reputation for sound geothermal resource management is looked to by several other nations as a good practice example, and New Zealand is considered to be internationally leading in this space. While there is always room for improvement, the NZGA seek that our good practice experience is not lost through the RMA reform process. Implementation of the RMA has been helped by the development of Regional Plans and Policy Statements, by National Policy Statements and by case law around the details, and has provided a suitable framework for geothermal use and development. We are keen to speak further to this in our verbal presentation of this submission.

24. An adaptive effects management framework is currently applied to geothermal resource use. This includes the development of reservoir management plans, robust and ongoing monitoring to enable adaptive management of effects as new information becomes available, and the requirement to establish a peer review panel, as conditions of resource consents. Adaptive reservoir management also has uncertain results, therefore an over-precautionary approach would limit our ability to innovate, to ensure the sustainable and efficient use of geothermal resources.

25. The NZGA are therefore keen to see this good work and management continued through a robust and adaptive framework for enabling operation, future research and exploration to inform existing and future geothermal resource use and development.

26. The NBA exposure draft includes the following definition of the precautionary approach in Part 1, Section 3 as:

> *"Precautionary approach is an approach that, in order to protect the natural environment if there are threats of serious or irreversible harm to the environment, favours taking action to prevent those adverse effects rather than postponing action on the ground that there is a lack of full scientific certainty"*

27. Part 3 of the NBA exposure draft relating to the National Planning Framework ("NPF") includes requirements at Sections 16 and 18 to apply a precautionary approach to the setting of environmental limits: "the Minister must apply a precautionary approach" (Section 6), and the use of a precautionary approach is one of the 'implementation principles' for the NPF.

28. The application of the precautionary approach follows through to the planning committee, in Section 24, where these committees are required to "apply the precautionary approach" when making decisions on any Natural and Built Environments Plan.

29. Environmental limit setting is detailed in Part 2, Section 7. In this section, the purpose of environmental limits, being the protection of either or both of "the ecological integrity of the natural environment" and "human health" is supported in principle by the NZGA.

30. The adoption of a precautionary approach already exists in the legislative framework for managing natural and physical resources in New Zealand, with some examples of its use including:

    a. Section 61 of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012, which requires that in making decisions, where information available is uncertain or inadequate, a marine consent must favour caution and environmental protection. In achieving this, the EEZ Act requires that the marine consent authority must first consider whether taking an adaptive management approach would allow the activity to be undertaken.

    b. Section 7 of the Hazardous Substances and New Organisms Act 1996 requires those who exercise functions, powers and duties pursuant to the Act are required to adopt a precautionary approach.

    c. The New Zealand Coastal Policy Statement includes Policy 3, which has a requirement to "adopt a precautionary approach towards proposed activities whose effects on the coastal environment are uncertain, unknown or little understood but potentially significantly adverse".

31. However, the way the precautionary principle is proposed to be incorporated in the NBA exposure draft raises concerns for the NZGA. We are concerned that the inherent lack of certainty associated with research, development and exploration of geothermal resources, and uncertainties inherent in the operation of consented geothermal projects, could see development in this space stifled by the application of the precautionary approach to avoid adverse effects that may or may not occur, without considering the likely substantial benefits of using geothermal energy. The NZGA is also concerned that the precautionary approach, requiring the avoidance of adverse effects where information is uncertain, unknown or not well understood, does not also require a plausible causal link to be established between the effects and the activity being proposed.

32. Lack of certainty is a reason to take care, but the NZGA suggests that requiring certainty of the nature and scale of environmental effects before activities can commence is an unrealistic requirement that cannot be met in practice.

33. NZGA understands that "The NBA is designed to give central government and councils, with iwi, hapū and Māori, a larger role in promoting activities and uses to achieve positive outcomes"[6]. The NZGA does not have confidence that the NBA exposure draft achieves this for activities such as geothermal resource use and development, where elements of research, development and exploration are required to better understand both the resources, the potential effects of their use and development, and how these can be appropriately avoided, remedied or mitigated.

34. **Relief sought:** The NZGA seek to ensure that the NBA does not take an over-precautionary approach to the research and development, including exploration and testing associated with the development, and the use of geothermal energy resources — recognising that the nature of geothermal development has uncertainty associated with it, but that geothermal offers significant benefits to the future of energy use in New Zealand, including as a contribution to achieving zero carbon targets.

Part B: Detailed Commentary on Key Points

Setting Environmental Limits with careful consideration

35. Naturally geothermally-influenced environments have different characteristics to environment systems that have no geothermal influence (e.g. lakes, streams, soils).

36. As drafted, Section 7 of the NBA outlines that environmental limits will be imposed through the NPF or through plans which protect "the ecological integrity of the natural environment" and/or "human health". These limits may be either qualitative or quantitative[7].

37. There is, however, no direction on what process will be followed for determining and imposing environmental limits, or any criteria to be used to inform when or why an environmental limit is to be imposed.

38. NZGA consider there is a significant risk that without direction and effective collaboration, single environmental limits will be imposed without understanding the full implications of what it would mean to achieve those limits, and without taking a balanced approach to considering the other benefits of a proposal. This could, as an example, have the perverse outcome of preventing projects that could significantly benefit New Zealand's effort to achieving low carbon emissions objectives.

39. **Relief sought:** The NZGA seek that a clear, specific, objective and informed process, with suitable criteria, be established and included in the NBA to direct when, how and why environmental limits are imposed.

[6] Parliamentary Paper on the Exposure Draft of the NBA 2021, para 88
[7] Parliamentary Paper on the Exposure Draft of the NBA 2021, para 113

40. **Relief sought:** The NZGA seek that the unique characteristics of geothermally-influenced environments are accounted for in setting environmental limits.

Competing Environmental Outcomes

41. The NBA provides no direction on how to prioritise competing environmental outcomes.

42. For example, the requirement to ensure "ecological integrity is protected, restored or improved" (Section 8(b)), has the potential to compete with the requirement for "the ongoing provision of infrastructure services to support the well-being of people and communities…" (Section 8(o)).

43. It is inevitable that the development of renewable resources will have some form of impact on the environment. This applies to all renewable energy sectors (e.g. hydro, wind, solar, biofuel). There needs to be an ability to balance sometimes competing outcomes, particularly where proposed activities offer significant benefits to New Zealand and the achievement of carbon zero goals.

44. The NZGA also note that there is the potential for competing interests between the requirements of the NBA and other legislation. For example, the focus of the NBA is on environmental protection and enhancement, while the purpose of the Climate Change Response (Zero Carbon) Amendment Act 2019 provides a framework to implement clear and stable climate policies, achieve greenhouse gas emission reductions and allow New Zealand to meet its international obligations.

45. **Relief sought:** The NZGA seek clear direction on how competing outcomes within the NBA and with other Acts are to be prioritised.

Importance of renewable energy in achieving carbon zero targets overlooked

46. Section 7 of the RMA gives the "efficiency of the end use of energy", "the effects of climate change" and "the benefits to be derived from the use and development of renewable energy" particular weight and consideration. This requires that all persons exercising functions and powers under the RMA must have particular regard to these matters. These matters were introduced to Section 7 through 2004 amendments focused on strengthening and promoting increased use of renewable energy.

47. Under the NBA exposure draft, renewable energy generation, storage, transmission and use are referenced in Section 8 "Environmental outcomes" in association with the provision of infrastructure services. While the recognition of the environmental outcomes associated with all aspects of renewable energy is supported, the NZGA consider there is a distinct lack of representation of the importance of renewable energy generation in relation to (j) reduction in greenhouse gas emissions and (p) regarding the reduction in risks from climate change.

48. The lack of linkage between these aspects overlooks the critical role that renewable energy plays in New Zealand achieving its ambitions to achieve zero greenhouse gas emissions by 2050.

49. **Relief sought:** The NZGA seek clear linkage within the NBA between the role of renewable energy generation, storage, transmission and use towards greenhouse gas emissions reduction and reduction in climate change risks to ensure that the role of renewable energy sources in achieving carbon zero and reducing climate change risks are appropriately recognised.

50. **Relief sought:** The NZGA also seek that the efficient use of energy is introduced as a clear environmental outcome in Section 8.

National Planning Framework (NPF) – an opportunity for renewable energy resources, including geothermal

51. The NBA exposure draft provides for the introduction of a NPF through regulations made by the Minister for the Environment. The NBA outlines that NPFs can be set at any national, regional or district scale and can set directions, policies, goals, rules, methods and provide criteria, targets and definitions.

52. Regulations under the NPF will either stand alone and have direct legal effect or be given effect to through plans or regional spatial strategies. The topics that a NPF must include are outlined in Section 13, but do not include outcomes for renewable energy development and use broadly, or more specifically for geothermal resource use and development.

53. The NZGA welcome this proposal and consider that there is a significant opportunity to support geothermal resource use and development through the use of NPFs. Geothermal resources span broad areas and as such, would be suitable for pan-regional planning frameworks to be applied to the Taupō Volcanic Zone (incorporating Bay of Plenty and Waikato Regions) and the geothermal resources in Ngāwhā, Northland.

54. The NZGA acknowledge that there is a general shortage of expertise in assessing and understanding geothermal resources at a regulatory level. A pan-regional NPF is an opportunity to optimise the expertise available, by providing a consistent and comprehensive approach to the management and use of geothermal resources at a scale relevant to the resources themselves, while avoiding existing cross-boundary issues at a regulatory level that add unnecessary complexity, uncertainty and duplication.

55. **Relief sought:** The NZGA seek that the government direct the development of a NPF directly related to the use and development of renewable energy resources and in particular geothermal resources, applying to the Taupō Volcanic Zone (Bay of Plenty and Waikato Regions) and the geothermal resources found in Ngāwhā, Northland.

Efficient use and development of natural and physical resources is not included

56. The NBA seeks the protection and restoration of natural and physical resource, however does not consider how the ongoing sustainable use of natural and physical resources can occur alongside these objectives.

57. Unlike current requirements in Section 7 of the RMA, to have particular regard to the efficient use and development of natural and physical resources, there are no requirements for efficiency of resource use anywhere in the NBA exposure draft.

58. Geothermal resources represent the efficient use of natural resources, and provide a significant portion of the country's energy needs. They also offer significant potential to contribute more and to play a major role in future carbon zero objectives.

59. The NZGA Geoheat Strategy for Aotearoa NZ (2017 -2030)[8] is one document which provides strategic direction for sustainable growth in geothermal direct heat use. It is a useful example to demonstrate the principles that NZGA seeks to achieve for successful geothermal development.

60. Figure 2 illustrates the four guiding principles and seven success factors identified through stakeholder engagement and consultation on this Geoheat Strategy.

    Kaitiakitanga: Geothermal development is founded on sustainable business and resource use models, recognises kaitiaki, and supports current and future generations

    Shared: Strategy responsibility is shared, information will be open and benefits will be mutual

    Integrated: Sectors, organisations and disciplines support and complement each other in the pursuit of a common goal

    Focused: Our focus is direct use growth, building on strengths and current successes, to deliver maximum benefit to New Zealand

[8] https://nzgeothermal.org.nz/app/uploads/2017/06/Geoheat_Strategy_2017-2030__Web_Res_.pdf

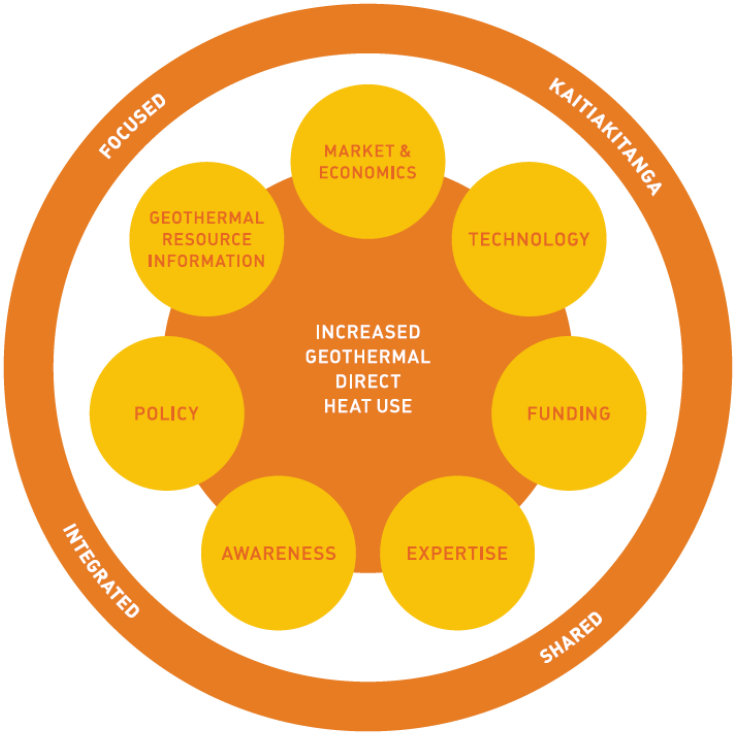

Figure 2: Four guiding principles and seven success factors of the Geoheat Strategy.

61. Alec Wilson, Chair of the Waiariki Geothermal Māori Advisory Group outlined in the Strategy foreword:

> *"Clean, renewable energy must be a significant part of our future, and with it comes benefits for our prosperity, health, and environment. There is clear opportunity for building substantive partnerships which support the significant influence Māori will have in the development of New Zealand's natural resources in the post-treaty settlement environment. 'Let us realise our geothermal potential.'"*

62. **Relief sought:** NZGA seek that efficient use and development of natural resources in particular be incorporated as an overarching requirement of setting environmental limits and in the development of environmental outcomes and other appropriate places throughout the Natural and Built Environments Act.

Part C: Recommendations

The NZGA seek that the Select Committee revise the NBA Act to:

i. Focus environmental limits and environmental protection on aspects of the environment that are of national or regional importance, and make specific provision for consideration of the benefits of resource use in meeting national objectives, including but not limited to the country's carbon goals, in decisions made under the NBA.

ii. Ensure that the NBA does not take an over-precautionary approach to research and development, including exploration and testing associated with the development, and the use of geothermal energy resources — recognising that the nature of geothermal development has uncertainty associated with it, but that geothermal offers significant benefits to the future of energy use in New Zealand, including as a contribution to achieving zero carbon targets.

iii. Provide clear, specific, objective and informed process, with suitable criteria, established and included in the NBA to direct when, how and why environmental limits are imposed.

iv. Ensure the unique characteristics of geothermally-influenced environments are accounted for in setting environmental limits.

v. Provide clear direction on how competing outcomes within the NBA and with other Acts are to be prioritised.

vi. Provide clear linkage between the role of renewable energy generation, storage, transmission and use towards greenhouse gas emissions reduction, and reduction in climate change risks, to ensure that the important role of renewable energy sources in achieving carbon zero and reducing climate change risks are appropriately recognised.

vii. Ensure that the efficient use of energy is introduced as a clear environmental outcome in Section 8.

viii. Direct the development of a NPF directly related to the use and development of renewable energy resources and in particular geothermal resources, applying to the Taupō Volcanic Zone (Bay of Plenty and Waikato Regions) and the geothermal resources found in Ngāwhā, Northland.

ix. Ensure efficient use and development of natural resources in particular be incorporated as an overarching requirement of setting environmental limits and in the development of environmental outcomes and other appropriate places throughout the Natural and Built Environments Act.

I welcome the opportunity to present to the Select Committee regarding this submission and can provide additional and supporting information on request.

Nāku noa, nā,

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Part D:
Appendix - The Case for Enabling Renewable Geothermal Energy in Aotearoa New Zealand

63. Geothermal is a vibrant, proven, indigenous renewable resource, which enables other industries to thrive and regions to grow. Aotearoa's legacy of low-carbon geothermal use gives the nation a competitive advantage in transitioning its energy sector and economy. Many of the elements needed for low-carbon geothermal to make a greater contribution to New Zealand's energy scene are established.

64. Geothermal energy has been decarbonising New Zealand's electricity and process heat sectors for over sixty years and is capable of innovating to decarbonise further so as to be a key part of Aotearoa's future energy solution. A supportive policy and regulatory environment will incentivise greater geothermal investment, technology development and fuel switching. Growth should also be encouraged in non-energy socio-economic geothermal streams, such as minerals, industrial tourism, Māori innovation, and training/education.

Geothermal investment will accelerate decarbonisation

65. As a small country, we have the advantage of being able to mobilise efficiently for robust outcomes with the appropriate policies and leadership. Geothermal development in New Zealand was directly enabled by Crown investment in exploration drilling in the 1950s — this investment has underpinned an industry worth over $3 billion[9]. New Crown investment, strong policy signals, enabling regulatory frameworks and suitable incentives will act as a springboard to build on this strong legacy of geothermal resource use.

66. New Zealand led the world in harnessing geothermal energy at scale, industrial geothermal direct use operation, and recently became the second country in the world to use geothermal for hydrogen production. Geothermal is a key part of our low-carbon energy future and has room to grow. There exist viable opportunities for the industry to grow and reduce emissions, and technology can be deployed in short timeframes. Geothermal operators and industry are keen to develop or deploy lower-carbon tech solutions and welcome government/policy support to increase uptake and increase the speed of transition.

Geothermal resources are a low-carbon electricity solution with significant growth potential

67. Geothermal energy generates 17% of New Zealand's electricity[10], and supplies 21% of New Zealand's primary energy[11]. Geothermal has been decarbonising the New Zealand energy sector for over sixty years. In the last ten years, the overall GHG emissions intensity of New Zealand's electricity sector approximately halved[12], due to displacement of fossil-fuel based generation, primarily by geothermal.

[9] business.scoop.co.nz/2017/04/27/wind-and-geothermal-emerge-as-significant-sources-of-energy/
[10] MBIE Electricity Statistics, 2021
[11] MBIE Energy in New Zealand, 2020
[12] McLean, K. and Richardson, I. 2019. Greenhouse Gas Emissions from New Zealand Geothermal Power Generation in Context. Proceedings 41st New Zealand Geothermal Workshop, Auckland, 25-27 November, 2019.

68. Geothermal energy offers a reliable, renewable baseload supply (i.e., producing power at a constant rate regardless of weather or climatic conditions). This manner of operation will enable further decarbonisation of the energy grid, with geothermal energy acting as the primary renewable baseload option, replacing gas/coal. In future, there will be an increased demand for renewable baseload power to stabilise the grid, with increasing variable power generation capacity expected (due to reduction in baseload fossil fuel plants and increase in weather- and climate-dependent renewables).

69. Expanding geothermal generation will assist in filling the gap in electricity supply, at a time when ca. 27 petajoules of electricity generation[13] (17.5% of the current supply, for current demand) would be required if all New Zealand's fossil fuel-based plant is closed. There are also opportunities to substitute electricity for fuels which currently power transport and process heat industries. World-class low-carbon geothermal resources advantage New Zealand environmentally, economically, and socially. The world energy markets are showing growing interest in geothermal as a sought-after sustainable energy solution; New Zealand companies and experts benefit from increased global geothermal growth.

70. We believe our challenge as a nation is in ensuring that we maximise all our renewable energy resources during our transition to a low-carbon future, especially baseload renewables. Baseload geothermal energy partners with and enables other renewable energy sources, such as solar, wind, hydrogen, and biomass. Maximising geothermal development (with its high availability of 90%-99%), through a more enabling regime and policy at the national level will reduce the overbuild (and associated life-cycle emissions) likely required for ensuring reliability from variable and weather-dependent energy sources, while minimising New Zealand's current reliance on fossil-based sources. Increased geothermal generation will ensure that our decarbonised future will remain affordable[14].

Geothermal is a low-carbon industrial process heat solution that enables other industries to thrive

71. Geothermal is used for more than electricity generation — the direct use of geothermal heat (8 PJ pa[15]) offers significant opportunities for industrial energy efficiency and decarbonisation. As a clean, reliable energy source, geothermal reduces production costs and improves environmental performance across a range of strong and competitive business sectors, including food and beverage, wood processing, horticulture, and dairy processing.

72. Since the 1950's, geothermal has offered New Zealand a low-carbon energy option that has been embraced by the timber and pulp/paper processing industries (e.g. Norske Skog Tasman, CHH, Asaleo Care, Oji Fibre Solutions, Sequal Lumber, Tenon). Successful industrial-scale conversions from fossil energy to geothermal sources have included Asaleo Care (tissue production, 2010), Tenon and Sequal

[13] MBIE Electricity Statistics, 2019
[14] Sepulveda, N.A., Jenkins, J.D., de Sisternes, F.J., Lester, R.K. 2018. The Role of Firm Low-Carbon Electricity Resources in Deep Decarbonization of Power Generation. Joule. Volume 2, Issue 11, 2403-2420.
[15] MBIE Energy in New Zealand, 2020

(timber drying, 2007 and 2015, respectively), and Oji Fibre Solutions (pulp production, 2019). Geothermal heat is also being used directly for dairy processing (Miraka at Mokai, 2010; Waiū Dairy in Kawerau, 2019), and being used to make biomass (e.g. wood pellets at Nature's Flame) or free up biomass (Oji Fibre Solutions) to decarbonise other processes.

73. Opportunities exist to further decrease carbon emissions in process industries. For example, the conversion of Tenon to geothermal from natural gas resulted in a CO2e emissions reduction of 93%[16]. The majority of process heat demand is supplied from fossil fuels, mainly coal or natural gas.

74. Geothermal process heat has scope for growth in co-located industrial processes around existing geothermal power plants, and recent conversions have occurred in Kawerau and Taupō to do just this. Existing or relocating process industries that utilise notable quantities of process heat should be encouraged and incentivised to relocate to a geothermal cluster.

Geothermal enables Māori socio-economic development

75. The principles of Te Tiriti o Waitangi, including self-governance, kaitiakitanga and resource ownership, are demonstrated by Māori land-owners, Māori-owned enterprises and other partners in geothermal developments and enterprises. There is scope to enhance this relationship by further embedding tikanga and Mātauranga Māori in geothermal management.

76. Geothermal is Aotearoa's indigenous renewable energy solution, and it creates genuine, active, and enduring partnerships with iwi/Māori. Māori are driven by principles of investing in projects that provide intergenerational prosperity and sustainability of natural resources. This philosophical view (combining kaitiaki and Māori economic development) aligns with geothermal resource developments, with the long-term project life of geothermal power plants i.e. 30+ years.

77. Most geothermal fields that have operating power stations, have some form of commercial or other beneficial arrangement i.e. ownership, fluid supply, royalties, land lease etc., with a Māori-owned enterprise. Geothermal energy developments have enabled true partnership and participation for Māori in the energy industry, as owners, developers, or co-owners and co-developers of geothermal fields (e.g. energy ecosystem owned by Tuaropaki Trust at Mokai; Ngāti Tūwharetoa Geothermal Assets at Kawerau; Tauhara North No. 2 Trust at Rotokawa). At Ngawha, a community geothermal energy solution addresses a lack of regional renewable power generation and high energy transmission costs.

78. Māori groups have led and grown successful businesses by leveraging their geothermal assets, people, and resources in other sectors. Māori innovation is driving new approaches to geothermal developments: collectives such as Waiū Dairy (a group of eleven Māori groups processing dairy products using geothermal heat) and whole ecosystem approaches, like Tuaropaki Trust (building a

[16] McLean, K., Richardson, I., Quinao, J., Clark, T. and Owens, L. 2020. Greenhouse Gas Emissions From New Zealand Geothermal: Power Generation and Industrial Direct Use. Proceedings 42nd New Zealand Geothermal Workshop, Waitangi, NZ, 24-26 November 2020.

business cluster that combines electricity, horticulture, green hydrogen, dairy processing, composting and more).

79. Significant revenues/profits from geothermal enterprises create opportunities for Māori shareholders to further development aspirations, and funds are reinvested in their people through financial, health, wellbeing, educational, cultural, and sporting endowments.

Geothermal energy use catalyses regional growth

80. High-temperature geothermal resources are a competitive regional advantage, catalysing decentralisation of high energy businesses and promoting regional tourism. Without conversion to electricity, geothermal heat energy (direct use) is typically used locally due to the costs of long (in excess of several kilometres) pipeline systems. This necessitates high energy users across a range of sectors (e.g. food and beverage, horticulture, tourism, wood processing) locating their businesses in these regions. Clusters of business parks can be (and are) created around geothermal (e.g. Kawerau and Tauhara).

81. For the Bay of Plenty, Waikato and Northland, high-temperature geothermal resources are a part of regional identity beyond electricity generation and industrial heat applications, supporting geothermal tourist parks, cultural experiences, and spa and wellness facilities. There is scope to not only grow electricity and industrial and commercial ventures, but also to pair geothermal tourism more closely with outreach, education, and industrial energy use into the future. Sustainable resource management frameworks (e.g. develop/protect classifications for geothermal fields) ensure these different uses for geothermal can be effectively supported.

82. Geothermal energy benefits regional economies by providing employment and stimulating economic activity (by attracting businesses into geothermal regions), while providing affordable and reliable energy. Geothermal energy developments can improve social outcomes as they are significant employers. For example, recent funding towards geothermal developments in Rotorua support 460 jobs in the new Wai Ariki Hot Springs and Spa, and 190 jobs in the Taheke Geothermal Power Station[17] development.

Geothermal provides innovative commercial opportunities

83. The high temperature geothermal industry is keen to advance beyond existing technologies and conventional geothermal resources. Some opportunities on the horizon are:

    a. Hotter, deeper resources (supercritical geothermal) offer an as-yet unknown energy potential (being explored in the New Zealand Government funded *Geothermal: The Next Generation* research programme).

[17] www.beehive.govt.nz/release/rotorua-benefits-over-62-million-boost

b. Geothermal energy could form a key component of hybrid energy systems. For example, surplus renewable electricity generation can be used to produce green hydrogen, which is stored and then rapidly converted back to electricity when renewables cannot meet energy demands. Tuaropaki Trust and Obayashi Corporation are exploring this opportunity.

c. Closed-loop and carbon recycling[18] technologies are being developed overseas, gaining investment from multi-national energy companies and could be deployed in New Zealand.

84. Additional opportunities, beyond expansion of electricity generation and process heat, include mineral extraction from geothermal fluids (e.g. Geo40, lithium-extraction), strategically aligned with increasing global demand for rare earths for EVs and batteries.

85. Geothermal energy also offers a sound opportunity for those regions without high-temperature geothermal fields. Low-temperature geothermal energy is everywhere. In all regions, the natural heat flow (increasing about 25-30°C for every kilometre depth) offers a primary energy for low-grade process heat. This geothermal energy can be accessed using existing technologies, in use internationally, and has potential, especially in large residential, large space builds. Ground-source heat pump technologies (for space heating and cooling) and low enthalpy power generation technologies are ready to deploy. While these technologies are in use extensively internationally, the market is immature in New Zealand. Growth in this area, to transition to or create new industries (which displace carbon-based heating) requires policy support and feasibility studies.

Geothermal is a New Zealand icon and legacy, on a global stage

86. Geothermal is an iconic kiwi symbol. As well as being home to numerous world-class geothermal operations, Aotearoa benefits from the intrinsic value in our geothermal landscapes, biodiversity, and recreational potential. Geothermal stories and geothermal energy have been part of Māori culture for generations, and geothermal is entrenched in our modern history.

87. Geothermal is one of the ways we introduce New Zealand to the world. New Zealand's investment in geothermal has produced significant intellectual property (IP), and our experts, their knowledge, and technical skills, are sought-after internationally.

88. New Zealand leverages domestic geothermal skills and IP (consulting, science, engineering and training) to maintain a large international service industry. Entities include Jacobs, MB Century, MTL, Thorndon Cook, Aecom, Beca, Seequent, Upflow, GNS Science, Wintec and University of Auckland, as well as a host of smaller companies and independent consultants, and the work done overseas by New Zealand's geothermal electricity generation companies. Our expertise attracts students and professionals to train in New Zealand institutions and organisations. Our technical support for geothermal developments throughout the globe, (usually in places with high-carbon power generation

[18] www.carbonrecycling.is/

markets) positively impacts the global carbon balance by displacing fossil-fuel based energy generation and reducing CO_2 emissions outside of New Zealand.

89. Geothermal is a New Zealand pioneering engineering innovation. We have developed expertise to support the global geothermal industry. As early-adopters, New Zealand's geothermal companies have helped to develop international best practice – including exploration, reservoir management, design, engineering, and environmental modelling.

90. Our geothermal leadership has enabled New Zealand to expand its sphere of influence in foreign affairs and diplomatic settings. This includes support for NZ-based training of international students, and in New Zealand assistance programmes supporting geothermal development in, the Caribbean, Indonesia, and East Africa, where it is acknowledged that New Zealand geothermal skills have a key role to play in decarbonising the economies of these regions.