24 November 2021

Attn: Submissions Analysis Team

Ministry for the Environment

Environment House, 23 Kate Sheppard Place

Wellington 6011

**Submission on Te hau marohi ki anamata: Transitioning to a low-emissions and climate-resilient future**

## Nau mai, Haere mai, Welcome to the Geothermal decades of Aotearoa

The New Zealand Geothermal Association (NZGA) would like to thank the Ministry for the Environment for the opportunity to comment on Te hau marohi ki anmata: Transitioning to a low-emissions and climate-resilient future.

We would be happy to discuss this submission further.

## New Zealand Geothermal Association

The NZGA, incorporated in 1992, is a non-political, non-government 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 domestic and international stage.

NZGA membership comprises ca. 400 individuals, as well as corporate members, representing geothermal electricity generation, research organisations, regional economic development agencies, engineering consultants, service providers, technology companies, planning consultants and Māori trusts. This diverse and skilled association works, embraces and lives with geothermal resources in Aotearoa.

## Our Eight recommendations:

**Rec (1): R&D to remove barriers and massive deployment of proven geothermal technologies for massive rollout (page 15)**

**Rec (2): R&D to remove barriers basic research, development, demonstration, and commercialisation for emerging geothermal technologies to expand market opportunities (page 15)**

**Rec (3): Revise the input assumptions modelling geothermal growth to follow upward trends (page 15)**

**Rec (4): Expand the definition of carbon sequestration in Emissions Trading Scheme allowing technologies to be recognised apart from forestry (page 16)**

**Rec (5): Speed up innovation in carbon capture and sequestration technologies in the geothermal industry to build a net carbon negative geothermal footprint (page 16)**

**Rec (6): Time necessary critical actions for 3 budget periods (page 17)**

**Rec (7): Congruence of government policies to ensure no perverse outcomes (page 21)**

**Rec (8): An inclusive and equity transition needs careful considerations by policy implications for businesses and households (page 22)**

## This submission outlines these five parts:

***A) the importance of meeting our Nationally Determined Contributions (NDC),***

***B) the challenges or barriers in the Energy and Industry sector,***

***C) the geothermal solutions***

***D) our recommendations***

***E) Co-benefits of utilising geothermal resources.***

## Part A: The Importance of meeting our Nationally Determined Contributions

***The greatest danger to our planet is the belief that someone else will do it for us.***

1. There have been many consultations over the past few years, recommendations that result in small actions. Our domestic emissions are still on the upward trajectory. We stepped up our Nationally Determined Contribution (NDC) before COP26 but tax-payers will pay a hefty price to meet our NDC target by relying on international carbon credits. By 2030, New Zealand needs to reduce 150 million tonnes of $CO_2e$ and Minister Shaw announced that 2/3 of the emissions reduction (100 million tonnes) will be from purchasing international carbon units that costs $6.5 billion tax-payers money ($65 per unit) and only 50 million tonnes come from domestic actions. THIS IS WRONG.

***The pace of change and the three emissions budgets are lagging our net-zero target***

2. NZGA supports the set of principles outlined in the consultation document. The time lost due to the COVID-19 pandemic and the delay in announcing the emissions reduction plan until end of May 2022 amplify the urgency to curb our emissions. We no longer have the luxury of time to allow for a weak response in Budget Period 1. Aotearoa must step up as a climate leader (we should not be followers in this space), strengthen our emissions reduction and place Tiriti o Waitangi and equity at the heart of our climate response. The tools to achieve internationally significant change are within our borders, we must be brave and embrace them to ensure that we can meet our net-zero targets.

### *Working with our Tiriti partners*

3. As guardians of the gifted geothermal resources, engaging with tangata whenua is central to NZGA's work. Tangata whenua have a special relationship with the natural resources that we rely on. To have deep and meaningful partnerships, the government and NZGA need to interact with various iwi, hapu, and ahu whenua trusts around operational sites where geothermal resources present. For example, in Taupō, Contact Energy have continued to work constructively and transparently with Tauhara hapū, to understand hapū interests in relation to their development plans for Tauhara. Their commercial partnership with local Māori Lands Trust Tauhara Moana has been constructive in relation to geothermal access rights.

### *Geothermal resources need protection*

4. New Zealand's geothermal policy and regulatory regime is internationally recognised as global best practice. Currently, environmental protection occurs *alongside* geothermal development, through a thoroughly consulted, clearly spatially based allocation that ensures geothermal systems with importance intrinsic or cultural values are protected and development of other systems is enabled under the Resource Management Act.

5. Understanding the health of the geothermal resource and impacts on hau kāinga can provide insight into desired outcomes. These include, for example, protection of the rights of hau kāinga to restore and maintain access to the geothermal resources and to protect the traditionally held geothermal resources which includes the ability to ensure their sustainable use in Rotorua.[1] Currently, Nona Taute at University of Auckland is working on bringing Mauri values and conventional geothermal development framework together in a construct that can have wide reaching benefits.[2] Geothermal developments must consider the guiding principles of kaitiakitanga for geothermal resources with full consultation and regard for equitable benefits in geothermal developments.

### *Geothermal enables Māori socio-economic development*

6. The principles of Te Tiriti o Waitangi, including self-governance, kaitiakitanga and resource ownership, are demonstrated by Māori land-owners, Māori-owned enterprises (e.g. ahu whenua trusts) 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.

7. 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.

8. 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.

[1] Nga Wai Ariki o Rotorua: He Kohikohinga: Hau Kāinga perspectives on the health and wellbeing of geothermal taonga within Rotorua, p.47.
[2] https://unidirectory.auckland.ac.nz/people/profile/dtau326

energy ecosystem owned by Tuaropaki Trust at Mokai; Ngāti Tūwharetoa Geothermal Assets at Kawerau; Tauhara North No. 2 Trust at Rotokawa). At Ngāwhā, a community geothermal energy solution addresses a lack of regional renewable power generation and high energy transmission costs.

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

10. 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.

## PART B: ENERGY AND INDUSTRY: UNPARALLEL CHALLENGES EXPERIENCING IN THE ENERGY SYSTEM

### *Challenge 1: Decline in energy security score*

Energy trilemma: NZ ranking 9th equal in World Energy Index[3].

11. We have slipped down the rankings, we have used too much coal in the last year, the MBIE Battery project will only supply stored electricity that will lose efficacy getting to the areas that demand it. Increasing geothermal baseload capacity reduces the demand on battery storage. It also provides off-grid opportunities presented by process heat and eases baseload demand and mitigates against price fluctuations.

12. If baseload geothermal electricity power stations are built to supply baseload electricity demand rather than relying on variable hydro at around 45% load factor or wind at around 40%, then less overbuild will be required at lower capital cost, and we will be less exposed to the variabilities of these generation types – the intermittency of other renewable energies may be increased through the effects of climate change (geothermal is largely agnostic of climate variation).

    Geothermal is sustainable, secure and through strong joint venture partnerships ensures equitable outcomes.

### *Challenge 2: Underinvestment in renewable energy and fragmented environment research fund unable to deliver national geothermal priorities*

13. The Productivity Commission's report found that New Zealand's labour productivity is significantly lower than in other small advanced economies (SAEs)[4] and New Zealand is lagging behind on CleanTech. For example in the Global CleanTech Innovation Index 2017, New Zealand was ranked 22nd overall and was the lower scoring small advanced economy.

14. Independent research [5] commissioned by Callaghan Innovation suggests that New Zealand's CleanTech innovators are raising 95% less funding than those in other small advanced economies. In addition, the number of New Zealand CleanTech innovators raising funds is less than that in other small advanced economies.[6]

15. There is a widespread view that there is a disconnect between many government documents emphasising the strategic importance of environmental research and the actual research investments that are made. It is not that such investments are unable to be related to the various strategies at some level, they are simply too broad and open-ended. Rather, the way resources are allocated engenders little confidence in our ability to maintain a comprehensive portfolio of environmental research that addresses national priorities over time. Furthermore, these mechanisms do not appear to meet and understand the nation's environmental research needs.

16. These concerns are in part a reflection of the fragmented funding machinery that is being used. Multiple models of investment have been developed over the years, which makes a joined-up view of the

[3] https://trilemma.worldenergy.org/#!/country-profile?country=New%20Zealand&year=2021

[4] *New Zealand firms: Reaching for the frontier*, Productivity Commission, 2021

[5] *New Zealand Climate Tech for the World*, Cleantech Group, 2021.

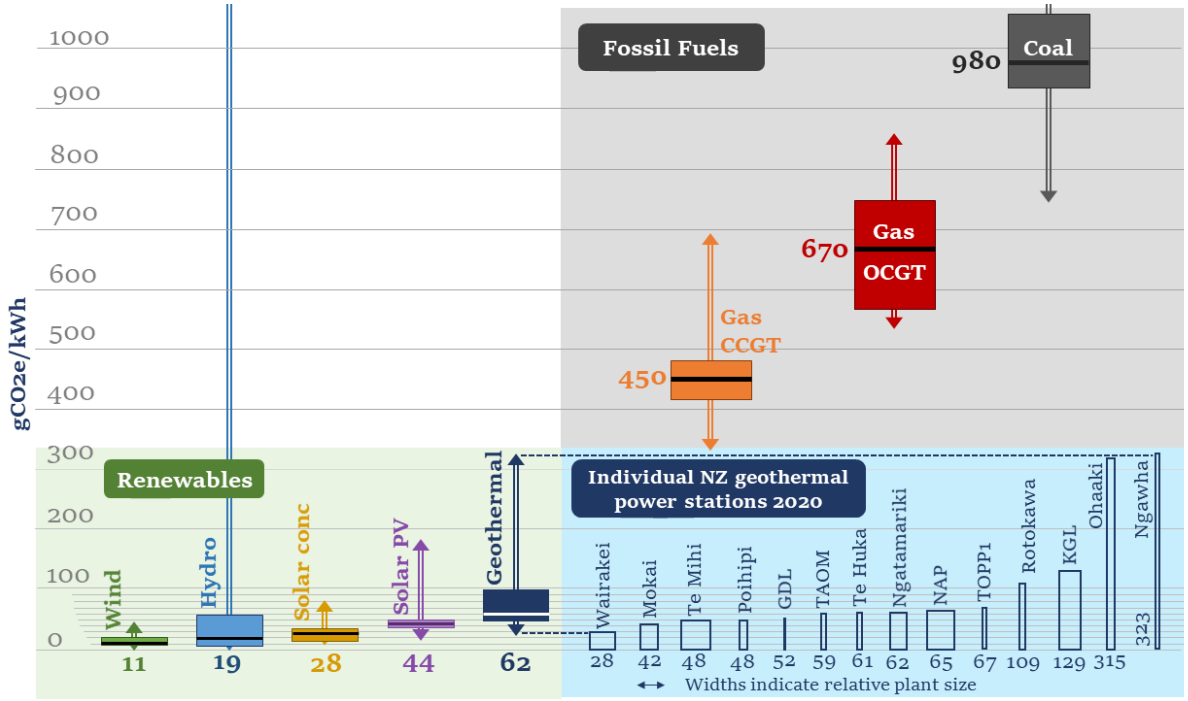
[6] https://www.callaghaninnovation.govt.nz/sites/all/files/CleanTech-Making_it_happen_for_NZ.docx.pdf

environmental research landscape almost impossible to achieve.[7] This disjointed nature and approach has left the research landscape behind in terms of energy solutions and the drive towards net-carbon zero.

***Challenge 3: There are NO zero carbon renewable energy sources. The government is using the wrong metrics to compare renewable sources.***

17. Power generation is an inherently carbon-releasing process. There is no such thing as a carbon-free energy source of electricity generation. Concrete structures used to hold back immensely powerful volumes of water, smelting of high-grade silica to build the most efficient photovoltaic (PV) solar panels, natural carbon emissions from geothermal plants and the manufacture and shipping of wind turbine blades all have implications for the release of carbon. What is critical for the future of Aotearoa's energy mix is to consider what resources will have the lowest overall life-cycle emissions intensity. The figure below shows the range of life-cycle emissions by energy source.[8]

**Figure 1: Full life-cycle emissions intensity by electricity generation fuel types ($gCO_2e/kWh$)**




18. Seeking the energy sources that have the lowest life-cycle emissions factor is the key to unlocking a sustainable energy future, geothermal is one of these energy sources that remain within reach for Aotearoa's energy future. Further, the technology employed in wind, solar, biomass, etc. all have variable emissions profile over their life-cycle. Whilst we acknowledge that carbon-based fuel sources are indeed

[7] https://www.pce.parliament.nz/media/197111/report-environmental-research-funding-review-pdf-32mb.pdf

[8] McLean, K., Richardson, I., Quinao, J., Clark, T., and Owens, L. 2021. Greenhouse Gas Emissions From New Zealand Geothermal: Power Generation and Industrial Direct Use. Proceedings 43rd New Zealand Geothermal Workshop, Wellington, NZ, 23-25 November 2021.

the source of significant emissions, the 'silver bullet' of wind, PV, biomass and hydro must be considered against the availability of energy generation (e.g. sunny days, windy days, rainy years) and as such the energy future of Aotearoa must consider what other sources are domestically available: geothermal is one of these.

19. Below is a table comparing various renewable sources illustrating the breadth of emissions from renewable sources. This shows that the generation technology may be low-carbon, but the construction and implication of it must also be factored into the emissions intensity of its generation profile.[9]

**Table 1: Estimation of life-cycle GHG estimates from different renewable energy technology**

| Renewable energy technology (RET) | Life cycle GHG estimates ($gCO_2$-eq/$kWh_e$) | | |
|---|---|---|---|
| | IPCC | UK | This study |
| Wind – Onshore | 12 | 20–96 | 8–124 |
| Wind – Offshore | – | – | 5–24 |
| Hydro | 4 | | 2–75 |
| Wave | – | 12–39 | 12–50 |
| Tidal | – | 10–20 | 10–50 |
| Geothermal | 45 | – | 11–78 |
| Photovoltaic | 46 | – | 9–300 |
| Solar thermal | 22 | 75–116 | 30–150 |
| Dedicated biomass | 18 | 25–550 | 14–650 |
| Waste treatment | – | – | 97–1000 |

### *Challenge 4: No technology-enabled carbon sequestration is recognised in Emissions Trading Scheme*

20. Carbon sequestration is not a new technology and its contributions being unrecognised in the ETS misses a significant opportunity for Aotearoa. Unlocking our domestic knowledge and capabilities to capture and sequester carbon will help shift us closer to our net-zero goals. By leveraging our expertise in geothermal and petroleum industries, using the subsurface of Aotearoa to put carbon back underground makes sense not only for our economy but for the benefit of the global community.

[9] Nana Yaw Amponsah, Mads Troldborg, Bethany Kington, Inge Aalders, Rupert Lloyd Hough, Greenhouse gas emissions from renewable energy sources: A review of lifecycle considerations, Renewable and Sustainable Energy Reviews,Volume 39,2014,Pages 461-475, ISSN 1364-0321, https://doi.org/10.1016/j.rser.2014.07.087 .

# PART C: SOLUTIONS: THE ROADMAP TO NET-ZERO WITH GEOTHERMAL RESOURCES. GEOTHERMAL IS THE NEW GOLD AND PLENTIFUL

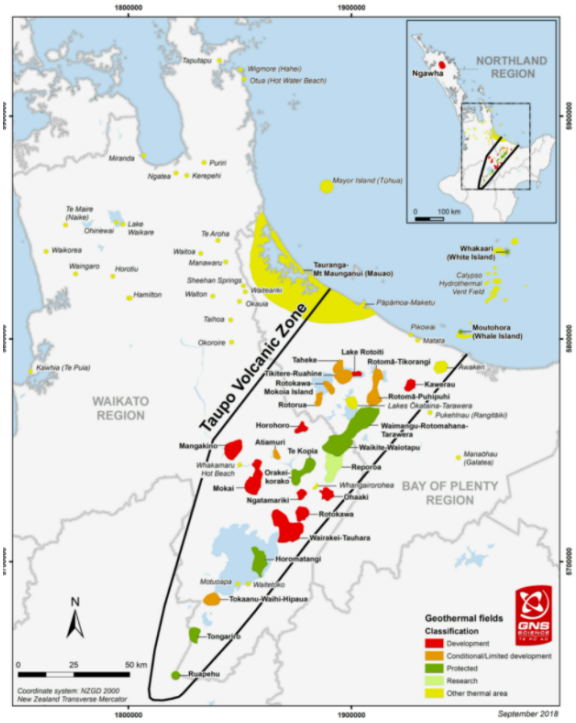
21. Geothermal is an abundant energy resource in Aotearoa that the word looks to with envy. We have the second highest installed geothermal energy profile per capita in the world (second only to Iceland) and are part of the elite group of countries who have more than 1000 MWe of installed geothermal electrical capacity.

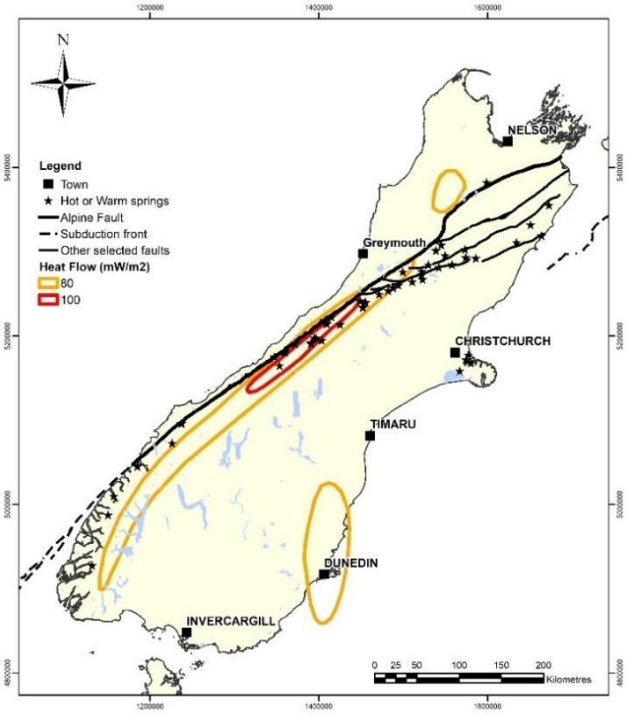
22. Aotearoa currently has more than 500 MWe additional geothermal electricity generation ready to be tapped with low-carbon emission profiles. The current construction of Tauhara II near Taupō will bring some 150 MWe online. Expansion near Rotorua is being explored at Taheke with proposals for 25MWe+, expansion at Ngawha 25 MWe+ and growth at Kawerau are the shovel-ready geothermal areas ready to contribute to our renewable energy supply.

23. Several other areas such as Tikitere, Tokaanu, Mangakino, Reporoa, Atiamuri, Ngatamariki, Rotoma, etc. are candidates to make further contributions to the energy profile of Aotearoa. These areas all have potential for growth and expansion of geothermal resources with the additional benefit of bringing opportunities for additional industrial installation and job growth.

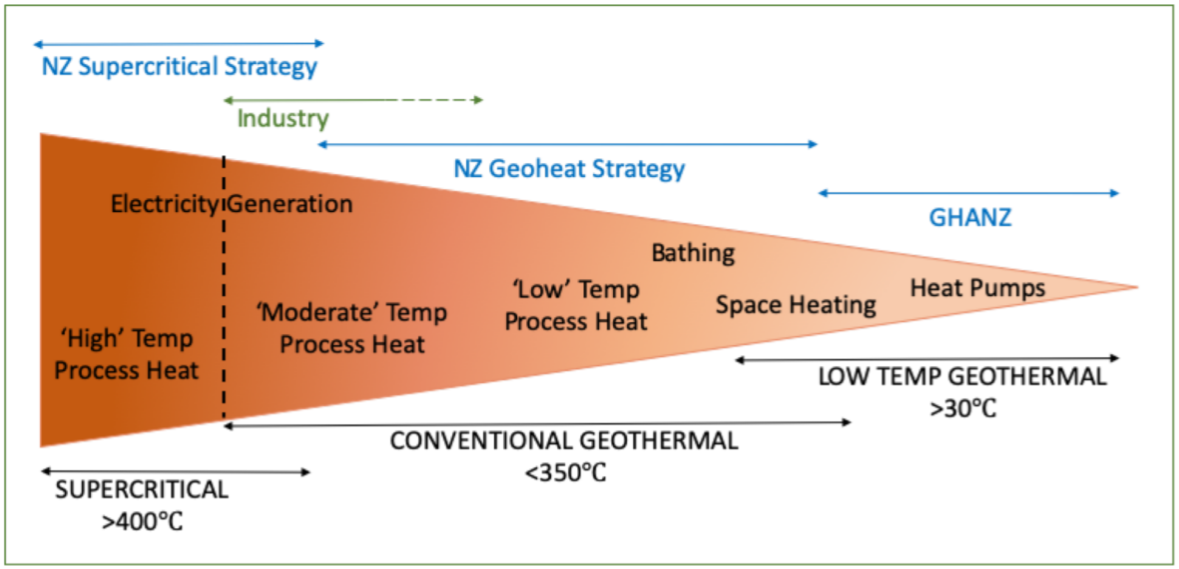
24. There is room for more however, and this is not just in industrial-scale electricity installations. The maps below show the Taupo Volcanic Zone as the focus of high-temperature (high energy potential) for geothermal resources but all of Aotearoa has a high subsurface geothermal potential. The advent of industrial heat-pump technology means that an existing heat source can be upgraded with the addition of a minor amount of energy, and geothermal is a perfect heat source for such applications. The maps below illustrate just how high-quality a geothermal resource exists in Aotearoa, it is simply needing the application of pilot studies, innovation, and desire to realise; the climate change emergency demands that we explore all options on the table and geothermal for all Aotearoa is one avenue to do this.

***Aotearoa geothermal heat map:***



***Solutions: New Zealand Geothermal Value Chain***




***Expanding on each category of geothermal potential:***

**a. Ground source heat:**

25. Ground Source Heat Pumps (GHANZ) must be considered when discussing the impact of heating in the Aotearoa New Zealand emission scheme. The installation of geothermal heat pumps can dramatically reduce electricity demand for industrial, commercial, and residential installations through efficient heat exchange with the ambient conditions at point of extraction found throughout Aotearoa New Zealand. The massive roll-out of these proven technologies can significantly reduce the need for additional electricity generation for space heating and further curtail carbon emissions.

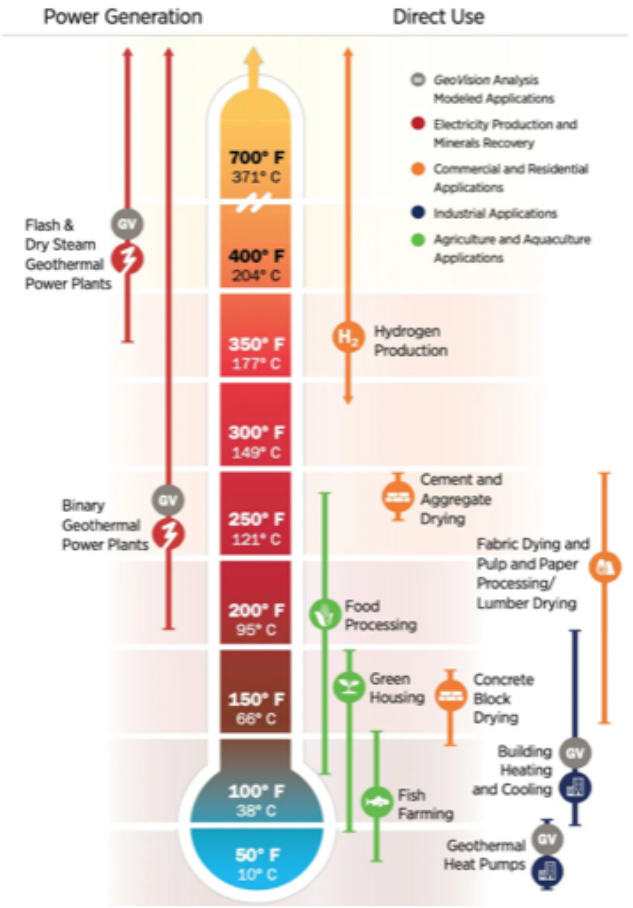
**b. Geoheat: direct heat use and industrial process heat: off-grid, co-locate, complementarity**

26. In 2017, the Association published the Geo-heat Strategy[10] which is the primary geothermal programme in Aotearoa New Zealand focussed on increasing the use of direct geothermal energy through industrial and commercial scale applications (e.g., glasshouses, timber processing, dairy processing). The importance of this strategy is that it provides guidance and drive towards increasing uptake of geothermal direct use which can in turn displace heat sources that rely on carbon emissions. It also reduces demand on the national electricity grid, as it is off-grid. Examples such as Nature's Flame and Te Awamutu dairy which demonstrate complementarity with other renewables. This configuration of geothermal proves as an efficient production of biomass pellets.

    Figure 2 below shows a schematic diagram of different applications from direct heat use.

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

**Figure 2: A schematic diagram of different applications from direct heat use.**[11]



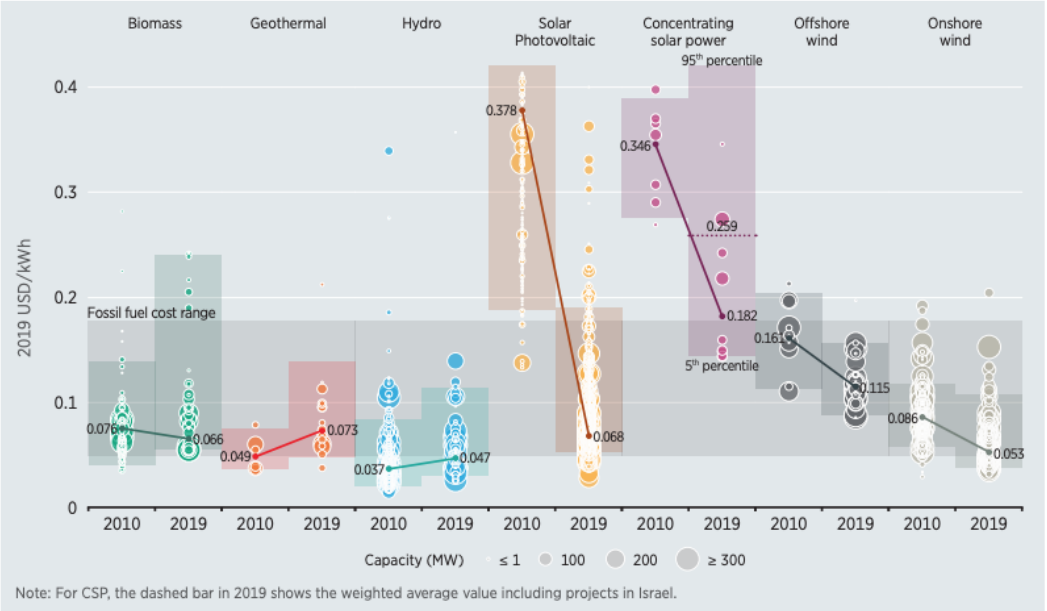

27. The Strategy's primary focus is to develop such resources in Northland, Waikato and Bay of Plenty regions with the goal of additional 7.5 PJ of geothermal utilisation. The secondary focus is to further push development of direct use of geothermal resources for residential scale use as well as the industrial use in other regions.

28. Every two years, we publish the bi-annual Action Plan where we celebrate our achievements and report on progress and details for the next two years. We will publish the 2022-2023 Action Plan in early 2022.

    We look forward to working with government in delivering this plan.

[11] https://causewaygt.com/

## c. Electricity generation: geothermal is the low-cost solution




*Source: IRENA Renewable Cost Database.*

*Note: This data is for the year of commissioning. The diameter of the circle represents the size of the project, with its centre the value for the cost of each project on the Y axis. The thick lines are the global weighted-average LCOE value for plants commissioned in each year. Real weighted average cost of capital (WACC) is 7.5% for OECD countries and China and 10% for the rest of the world. The single band represents the fossil fuel-fired power generation cost range, while the bands for each technology and year represent the 5th and 95th percentile bands for renewable projects.*

**Figure 3: Global LCOEs (Levelized Cost of Energy) from newly commissioned utility-scale renewable power generating technologies, 2010-2019 (IRENA,2019).[12]**

29. 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 plants are closed.

30. 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.

31. 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.

[12] ISBN 978-92-9260-244-4 Citation: IRENA (2020), Renewable Power Generation Costs in 2019, International Renewable Energy Agency, Abu Dhabi

[13] MBIE Electricity Statistics, 2019

### *d. Supercritical Geothermal: Deeper, Hotter, a game changer*

32. Geothermal has been a part of Aotearoa's energy story since Māori settlers arrived many centuries ago for cooking, bathing, and spiritual enrichment amongst other uses. The advent of technology to harness steam to generate electricity happened in Italy in the early 1900's but Aotearoa saw the first application of separating high temperature geothermal water and steam to generate electricity at Wairakei in 1958, a world first. Following this technological milestone, geothermal power has been removing carbon-fuelled sources across the globe. A new resource looms on the horizon for geothermal in Aotearoa, Supercritical Geothermal.

33. Supercritical geothermal is that which lies beneath the currently utilised geothermal systems that contribute 18% of our national electricity generation. Supercritical conditions lie at 4-7km depth in the central Taupō Volcanic Zone where fluids that exist in a state of energy 10x that of traditional geothermal fluids. Whilst these fluids have yet to be tapped in Aotearoa, significant international modelling and research indicates that their presence is here and potentially accessible. Currently, a workstream funded by the MBIE Endeavour Fund, **Geothermal Next Generation**, is seeking the framework and necessary works to enable exploration for these deep resources. However, more investment is needed in this space to drill deeper wells, test the fluid that comes from these wells and understand the impact these fluids could have on the energy landscape for Aotearoa. It is hypothesised that these supercritical geothermal fluids could have up to 10-fold the energy currently harnessed by conventional geothermal technologies. This means that the average well in use today at 3-5 MWe per well could be boosted to 30-50 MWe per well, a game changer.

34. International research in supercritical geothermal is a hot topic and works in Iceland, Japan, Indonesia and the USA are focussing efforts to realise this potential. Aotearoa sits on a wealth of knowledge and desire to see this resource become part of our energy mix. The challenges are comparable to that of the early days of Wairakei where new technology was met with scepticism but through hard work and perseverance, became a world-changing application of kiwi ingenuity and technological advancement.

35. Pursuit of supercritical geothermal for Aotearoa will add yet another string to the bow of our renewable quiver and will undoubtedly change the landscape for not only our domestic geothermal energy landscape but for the global geothermal community.

**In summary, geothermal is an important role in decarbonisation in Aotearoa New Zealand.**

***Solutions: The Draft Emissions Reduction Plan is dominated by matured technological solutions, emerging technologies are in the horizons***

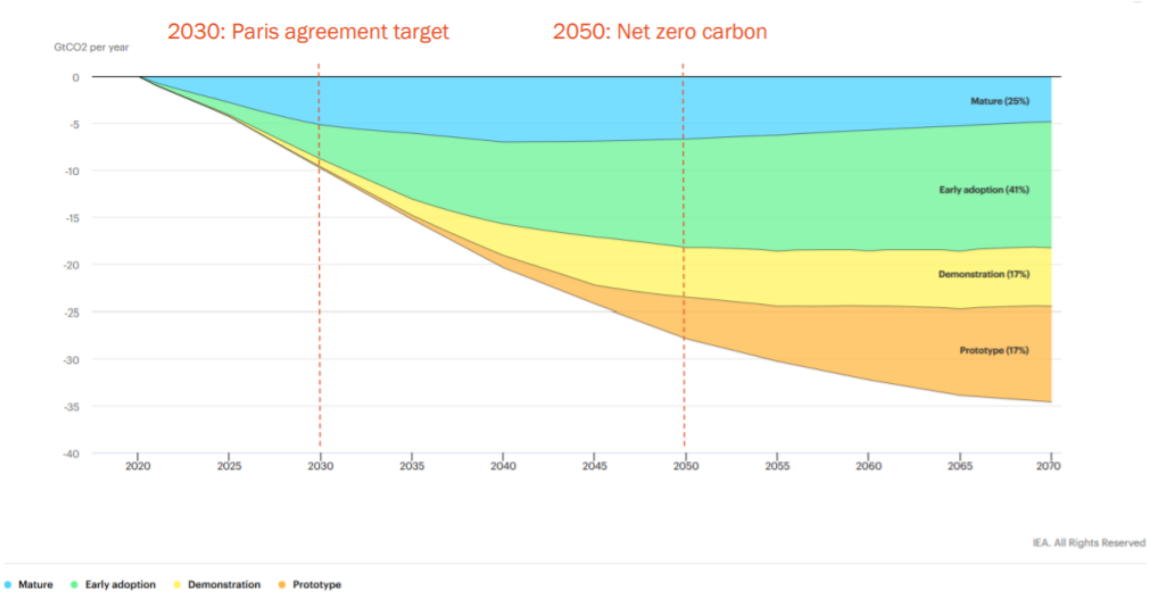



**Figure 4: Global energy sector $CO_2$ emissions reductions by current technology readiness category in the Sustainable Development Scenario relative to the Stated Policies Scenario, 2019-2070[14]**

36. The IEA estimates that commercially available low-emission innovations (mature or at early adoption stages, respectively in the blue and green on the above graph) have the greatest potential to reduce emissions by 2035 (end of Budget period 3). The clear implication of this is that New Zealand's emissions reductions commitments in 2030 and 2050 will mostly have to be met by proven technologies which are in-use today.[15]

14 https://www.iea.org/data-and-statistics/charts/global-energy-sector-co2-emissions-reductions-by-current-technology-readiness-category-in-the-sustainable-development-scenario-relative-to-the-stated-policies-scenario-2019-2070

15 https://www.eeca.govt.nz/assets/EECA-Resources/Research-papers-guides/Innovation-and-the-transition-to-a-low-carbon-future.pdf#page=12

# PART D: OUR RECOMMENDATIONS

***Rec (1): R&D to remove barriers and massive deployment of proven geothermal technologies for massive rollout (the blue section Figure 4):***

- $10 million for tangata whenua to identify barriers to development coincident to protection of their geothermal resources.
- $20 million Exploration fund to accelerate 'shovel-ready' geothermal development fields identified by regional councils as suitable for development.
- $10 million to explore the potential of smaller resources and allow small .5-10 MWe installations to have national significance
- $ 10 million over 5 years Information and awareness campaign to promote the use of geothermal resources

***Rec (2): R&D to remove barriers basic research, development, demonstration, commercialisation for emerging geothermal technologies to expand market opportunities (the green section in the Figure 4 graph):***

- $10 million over 2 years for industrial geothermal direct use transition and innovation pilots
- $30 million over 5 years unlocking supercritical geothermal by drilling a test well
- $100 million over 10 years to establish new geothermal industries
  - Geothermal minerals: such as lithium and silica
  - Geothermal hydrogen
  - Geothermal CO2 capture and repurpose geothermal methanol
  - Geothermal CO2 capture and storage
  - Other innovative industries that may emerge through geothermal research

***Rec (3): Revise the input assumptions modelling geothermal growth to follow upward trends***

37. The Lawless et al report [16]and Climate Change Commission estimates assume regulation will constrain both the pace of and quantity of new capacity additions. Correspondingly, the CCC projects an additional 252 MWe, while Lawless anticipates roughly 281 MWe (Table 6) in 2060.

38. In the submission to Climate Change Commission, Contact Energy[17] submitted that geothermal (existing and future capacity in NZ) generation would rise to 12,000 GWh by 2030. In other words, geothermal generation would grow by 4,400 GWh from 2020 (where the total generation was 7,600 GWh). This corresponds to an increase of 462 MWe of capacity, net of any de-ratings or decommissioning.

39. The Contact Energy estimate represents the new generation potential provided adequate policies are in place. There are many factors that will determine how much new geothermal capacity will actually come on-line by 2030, among them: the price of carbon, the NZD exchange rate, the cost of money, project

[16] https://www.mbie.govt.nz/dmsdocument/11334-future-geothermal-generation-stack

[17] https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/submissions/organisation-submissions/

costs (including permitting), the price of wholesale electricity, the demand for electricity, and the cost of alternative generation.

40. These factors are difficult to estimate. So, the CCC's estimation, driven by the projects currently permitted and announced, represents a P50 or likely scenario, while the Contact Energy projection expresses the potential upside (P90).

41. Accordingly, NZGA acknowledges the range of potential outcomes and clear government policy objectives will attract commercial investments to accelerate our decarbonisation pathway.

**Table 2: Contact Energy 's recommendation to Climate Change Commission, March 2021**

| |
|---|
| **Recommendation: Model geothermal generation growth to 12 TWh by 2030**<br><br>The Climate Change Commission should factor in increased growth in geothermal. Based on our analysis, we recommend that the Commission's stated contribution of geothermal is increased to:<br><br>2025 11 TWh<br>2030 12 TWh<br>2035 12 TWh |

### *Rec (4): Expand the definition of carbon sequestration in Emissions Trading Scheme allowing technologies to be recognised apart from forestry*

42. The government has set-out a "Just Transitions" framework for Aotearoa to enable the oil and gas community to have a leg-up in the transition to a net-zero economy. This is the sensible and practical approach to ensuring regions like Taranaki which have relied for years on carbon extraction efforts for economic growth to not perish and wilt under the demands of a net-zero economy.

43. Through a just transition, leveraging the skills of oil and gas experts calls for these skills to be employed to find new ways to address the looming issue of increasing carbon emissions. The area of carbon-capture and sequestration (CCS) is not a new area of research nor one that should be foreign to Aotearoa. Offshore CCS technology has been used since 1996 in off-shore Norway and has made leaps and bounds in the last 20+ years. Application of this technology to aid in our net-zero carbon future is essential to realisation of our climate goals.

### *Rec (5): Speed up innovation in carbon capture and sequestration technologies in the geothermal industry to build a net carbon negative geothermal footprint*

44. Support research into carbon sequestration technologies utilising geothermal expertise and develop innovative solutions that are relevant to New Zealand's geothermal industry. These innovations will progress geothermal to a net-negative industry through capture and sequestration of carbon. Baseload geothermal coupled with a net-negative emissions profile could be a significant game-changer of our energy market.

45. Work in geothermal-specific carbon capture is taking hold in Aotearoa's active geothermal fields. A consortia of geothermal plant operators are sharing insight, technology, and information on how to minimise gas emission from plant processes and reinject these gases underground. This represents a significant shift in the industry to find a 'grassroots' solution to a global problem right here in our back yard.

46. In addition to capturing carbon and other GHG in power plant processes, the advent of carbon capture technology using filters to remove carbon from the air and geothermal injection streams is making significant progress overseas in Iceland. New Zealand works closely with Iceland in many areas and carbon capture in geothermal fields is one area in which international collaboration will yield significant results for our nation. The technology employed in Iceland literally captures carbon from the air, mixes the carbon-dioxide with geothermal fluid and injects it back underground at the Hellisheidi geothermal station. [18,19] This process results in carbon being solidified (mineralised) in the subsurface, locked away and contributing to a negative emissions profile.

***Rec (6): Time necessary critical actions for 3 budget periods***

| | **Budget period 1 2022-2025** | **Budget period 2 2026-2030** | **Budget period 3 2031-2035** |
|---|---|---|---|
| **Energy and industry** | • Displace thermal electricity plants with geothermal and other renewable plants<br>• Design and implement National Energy Strategy with minimum of 60% renewable energy before 2035<br>• Use geothermal to help make biofuels<br>• Grow 'brownfield' development projects | • Implement National Energy Strategy with minimum 60% renewable energy before 2035<br>• Transition business using biomass to geothermal to free up biomass supply enabling increased biofuels demand<br>• Explore development of smaller non-developed (but deemed to be suitable for development) geothermal fields | • Review National Energy Strategy and increase renewable energy targets to support increased National Determined Contributions |

[18] https://www.bbc.com/news/world-43789527

[19] https://fortune.com/2021/03/06/carbon-capture-storage-rocks-net-zero-carbfix-startup-iceland/

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| | • Accelerate policy framework to enable smaller geothermal developments | • Investigate opportunities for district heating schemes where these contribute to zero carbon goals and can meet other goals within sustainable limits | |
| **Transport** | • Make geothermal hydrogen<br>• Roll out geothermal fluids extraction for minerals<br>• Push to electrify small transport | • Transition business using biomass to geothermal to free up biomass supply enabling increased biofuels demand | |
| Research, science, and innovation | • $10 million for tangata whenua to identify barriers to development coincident to protection of their geothermal resources.<br>• $20 million Exploration fund to accelerate 'shovel-ready' geothermal development fields identified by regional councils as suitable for development.<br>• $10 million to explore the potential of smaller resources and allow small .5-10 MWe installations to have | • $10 million over 2 years on geothermal direct use technology investigation and upskilling<br>• $30 million over 5 years unlocking supercritical geothermal by drilling a test well<br>• $100 million over 10 years to establish new geothermal industries<br>- Geothermal minerals: such as lithium and silica<br>- Geothermal hydrogen | • $50 million over 5 years unlocking supercritical geothermal by deploying drilling technology<br>• $100 million over 10 years to establish new geothermal industries<br>- Geothermal minerals: such as lithium and silica<br>- Geothermal hydrogen<br>- Geothermal $CO_2$ capture and repurpose geothermal methanol |

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| | national significance.<br><br>● $ 10 million over 5 years Information and awareness campaign to promote the use of geothermal resources | - Geothermal $CO_2$ capture and repurpose geothermal methanol<br>- Geothermal $CO_2$ capture and storage. | - Geothermal $CO_2$ capture and storage |
| Building: Ground source heat pumps | ● Demonstration of large-scale industrial heat pumps in known geothermal areas<br><br>● Invest $5M in industrial-scale heat-pump demonstration outside of Taupo Volcanic Zone | ● Deployment in new Urban planning act | ● Massive roll out in the new Urban planning act |
| Funding and finance | ● Recycle ETS revenue to providing transitional support to vulnerable households, businesses or communities; or funding special projects<br><br>● Expand EECA GIDI funding to massive roll out of decarbonising thermal consumption | ● Expand EECA GIDI funding to massive roll out of decarbonising thermal consumption | |
| Information and Awareness | ● $2 million per year from EECA to displace fossil and inefficient technologies with | ● $1 million to MBIE to publish Industry Transformation Pathway report with regional case studies | ● |

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| | geothermal solutions<br><br>• $2 million with Māori business for business case studies<br><br>• $2 million to collaborate with international partners to develop innovative technologies | • $5 million with Māori landowners for feasibility studies or borehole testing<br><br>• $10 million to establish demonstration sites | |
| Planning | • Integrating emissions reduction targets into RMA reform<br><br>• Integrating emissions into urban planning and funding<br><br>• Reduce time for EIA and Geothermal Consent Application Processing | • Allow provisions in NBeA for accelerated geothermal project consenting through a framework for sustainable and equitable management of geothermal developments that protects against adverse effects but coincides with development aspirations | • |
| Making an equitable transition | Transitioning from oil & gas industry? – leverage expertise for CCS<br><br>Expand off-grid geoheat solutions for regions that can benefit from large scale heat applications | Building new capability for geothermal hydrogen, methanol, minerals<br><br>Employment ratio outpaced the conventional industries | |
| Protection:<br><br>Natural & Built Environment Act | Protection of natural values and features that are significant (such as nationally rare geothermal features and | Build strong consultative framework with tangata whenua to identify which geothermal features need protection | Ensure the framework for geothermal resource management ensures sustainable management balances with the need |

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| | ecosystems within Protected Geothermal systems and the geyser field in Rotorua).<br><br>Continue the protection of ongoing customary use of geothermal. | and balance with climate emergency priorities | to use energy sources the climate emergency has required |
| Te Tiriti o Waitangi | Ensure that geothermal is placed to enable Maori socio-economic development through funding to Hapu and Iwi to understand geothermal potential. | Identify partnerships and clear principles to allow ahu whenua trusts to be established to develop geothermal resources | |
| Education | Improve public awareness on the benefits geothermal including electricity generation direct heat use to reduce carbon emissions, as well as tourism, wellness, cultural welling, and indigenous biodiversity.<br><br>Solidify Aotearoa's standing as a geothermal education leader through a government-funded geothermal centre of knowledge additional to the University of Auckland's present focus. Ensure education focuses on practical experience and project development. | Leverage domestic universities and polytechnical schools to upskill a workforce well rounded in geothermal protection, education, development, sustainability and utilisation | |
| Regulatory barriers and opportunities | Natural and Built Environments Act should ensure that a framework to enable sustainable management of resources | | |
| Technology-enabled carbon capture and storage in ETS | Invest $5M into identification of ideal subsurface reservoir CCS | Invest $25M to capture and injection plants for active geothermal plants | Invest $25M to enable new geothermal builds to build fully negative carbon emissions cycles coupled with gas capture |

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| | | | and atmospheric capture technology. |

### *Rec (7): Congruence of government policies to ensure no perverse outcomes*

47. An effective legislative framework for Aotearoa New Zealand requires a holistic overview and interconnectivity to guide decision-making and policy choices. There is a real risk that siloed thinking will place unnecessary obstacles in implementation of climate actions.

48. While the purpose of the Climate Change Response (Zero Carbon) Amendment Act provides a framework to implement clear and stable climate policies, achieve carbon emission reductions and allow Aotearoa New Zealand to meet its international obligations, other reforms such as Resource Management Reform, Water Reform, Research, Science and Innovation Reform and Health Reform could have the perverse outcome of preventing projects that could significantly benefit New Zealand's effort to achieving low carbon emissions objectives.

### *Rec (8): An inclusive and equity transition needs careful considerations by policy implications for businesses and households*

49. Increasing the ambition of the emissions reduction plan will foster significant changes in business environment in Aotearoa in the coming years. Industrial transformation in advancing emissions reduction technologies will create winners and losers, as government operationalises our climate pledge will favour new industries and innovation in low-carbon sectors. Some industries will be left behind. Some regions will decline.

50. Therefore, transitioning to a low carbon Aotearoa needs careful consideration which government agencies work together to clarify how they expect their policies to evolve. This is valuable for businesses to factor climate-related policies into their planning.

51. The Government also needs to consider how the price of renewable energy and heating relative to fossil fuels will prevent a rise in costs to households to balance energy trilemma. The currently consultation Energy Hardship initiative supports to improve New Zealanders on their wellbeing.

# PART E: CO-BENEFITS: GEOTHERMAL ENERGY USE CATALYSES REGIONAL GROWTH

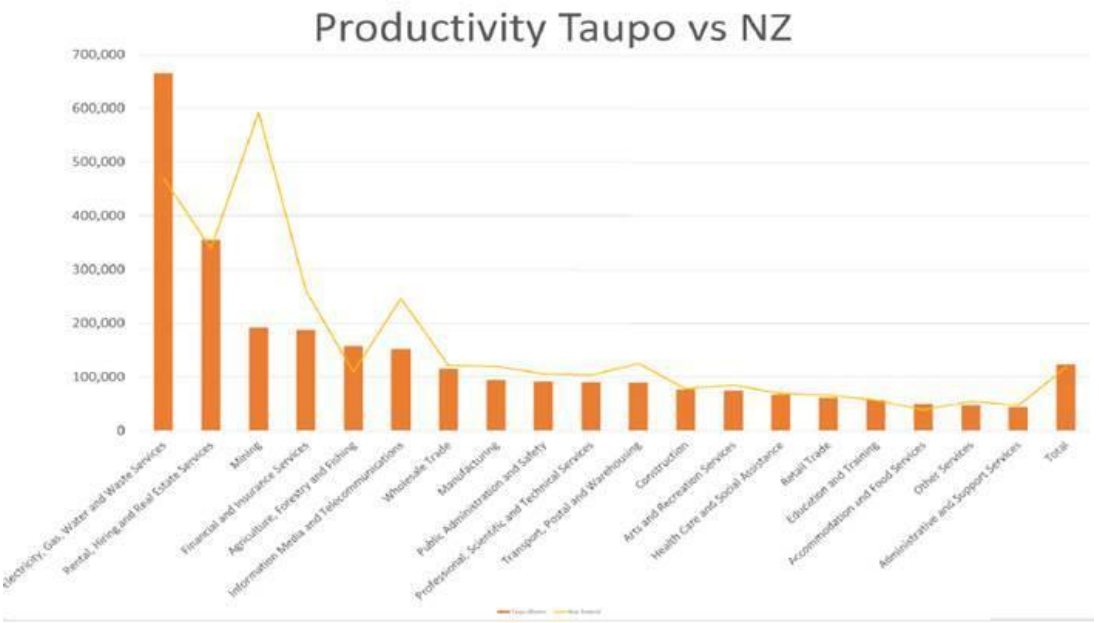
52. High-temperature geothermal resources are a competitive regional advantage, catalysing decentralisation of high energy businesses and promoting regional tourism. Without conversion to electricity or biomass, geothermal heat energy (direct use) is typically used locally due to the costs of long (in 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).

***Example: Bay of Plenty, Waikato and Northland regions***

53. 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.

***Example: Taupō district region***

54. Overall, the Energy & Utilities Sector (Geothermal sits within this) is the most productive sector in the Taupo District in terms of GDP contribution. Energy & [Utilities] is one of our smallest sectors (400 employees) but generates over $670K / employee, versus our largest industry, Tourism, which comprises about 35% of jobs, but only generates about $50K / employee.



***Example: Rotorua region***

55. 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 will potentially support 460 jobs in the new Wai Ariki Hot Springs and Spa, and potentially 190 jobs (during construction phase) in the proposed for Taheke Geothermal Power Station development for which exploratory drilling is currently taking place[20].

***Example: Industrial Symbiosis at Kawerau (ISK)***

56. Kawerau has the unique advantages of being a well-established wood processing centre and home to the world's largest application of geothermal energy for direct industrial use. Further, it is strategically located having proximity to well-established road and rail transport infrastructure and the Port of Tauranga. ISK aims to capitalise on this unique combination of factors by adopting progressive practices that embrace change, leading to a new industrial evolution of smarter, cleaner business. Members of ISK are varied and include wood/fibre processing; geothermal energy, industrial engineering, service businesses, Māori business groups and the Kawerau District Council. Kawerau is on the cusp of significant economic growth along with the rest of the Eastern Bay of Plenty. Kawerau's main growth project - the Kawerau Putauaki Industrial Development (KPID) - is one of the four key "catalytic" Eastern Bay of Plenty infrastructure projects identified in the Eastern Bay of Plenty Regional Development Project report completed in 2018. These four projects are viewed as being "… critical to unlocking other transformative projects" across the region. Specifically, KPID is expected to unlock significant benefits including generating an estimated 1,460 jobs and $183 million in local GDP by 2030.[21]

## Conclusion

Reaching net carbon zero is an enormous task that requires deep systemic change with authentic purposes.

Geothermal is a domestic energy source that will unlock net zero solutions, improve wellbeing, and improve economic standing throughout the regions.

No stone unturned, no one left behind, every carbon molecule counts!

We would be happy to answer any further queries.

Nāku noa, nā

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

[21] https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/submissions/organisation-submissions/

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