NZ Geothermal Association Submission to Productivity Commission report on transitioning to a low-emissions economy

Background
The New Zealand Geothermal Association (NZGA) would like to thank the Productivity Commission for the opportunity to submit on the Draft Report on Transitioning to a Low-Emissions Economy.

The New Zealand Geothermal Association (NZGA) is an independent, non-profit association that provides information on geothermal phenomena and utilisation for industry, government and educational organisations. In addition, the NZGA, as a member of the International Geothermal Association, contributes to the international exchange of information within the geothermal development industry. NZGA membership comprises participants, regulators, and interested parties within the geothermal community. It totals almost 300 members currently.

The New Zealand Geothermal Association supports a change to a low-carbon future and considers that the report comprehensively addresses many of the issues in achieving this goal. We see geothermal energy as being a key part of NZ's low-carbon future.

Our submission is in two parts:

Part One addresses some of the recommendations of the report.

Part Two addresses technical matters associated with the representation of geothermal energy conversion, to ensure full relevance and accuracy.

This submission will be published on the NZGA website, and we have no objection to it being published in any other setting.

Part One

The NZGA agrees with the recommendations of chapters 4, 5, 6, 7, 8, 12, and 13, and has no comment on the recommendations of the remaining chapters. We have no specific answers to the Questions asked in the Summary of Questions, as none are especially relevant to the NZGA or its members.

Part Two

Thermal Plant

In places the report refers to 'thermal generation' without differentiating between fossil fuel thermal generation and geothermal generation. For example, on page 320, 4th bullet, "holding surplus renewable generating capacity is an efficient option for reducing the need for thermal generation", the reference should be to "fossil thermal generation".

The same differentiation should be made elsewhere in the section.

Geothermal Energy Use and Greenhouse Gas Emissions:

Almost every reference to geothermal energy points out that geothermal electricity production releases greenhouse gases. However, it needs to be pointed out that in the long run, the quantity of naturally occurring greenhouse gases released from geothermal fluid when it comes to the surface will be the same more-or-less whether the surface discharge is natural or from a geothermal power station. The difference is that that it occurs over a much shorter timeframe when discharged from a geothermal power station. For a more complete and accurate understanding of the effect of geothermal energy use on GHG emissions, see Fridriksson et al., 2016:
https://openknowledge.worldbank.org/bitstream/handle/10986/24691/Greenhouse0gas0mal0power0production.pdf?sequence=1

In quantifying the emissions from any energy conversion source, more than the emissions during operation need to be taken into account. Other sources of discharges can include fossil fuel use during drilling (for geothermal), discharges associated with creation of large concrete structures (e.g. hydro dams), methane production from inundated vegetation in hydro dams decomposing, and the leakage and accidental discharge of hydrocarbon working fluids (typically pentane, butane, etc.) from geothermal binary plants. An analysis of life-cycle emissions of greenhouse gas emissions of different types of power plants, and an investigation of the effect of emissions of binary plant working fluids, which turns out to be minimal (Mattson *et al.*., 2017), can be found here: https://pangea.stanford.edu/ERE/db/GeoConf/papers/SGW/2017/Mattson.pdf

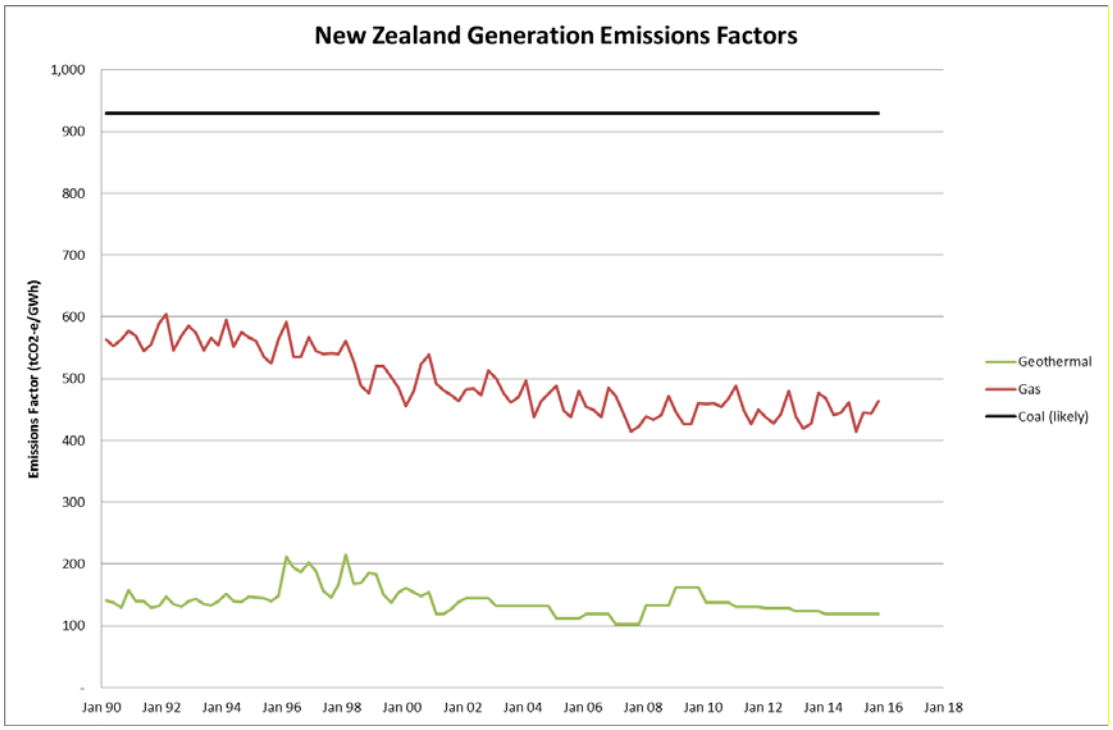
Life cycle emissions by New Zealand renewable electricity generation technologies have been analysed by Rule et al., 2009, who determined that geothermal is comparable to hydroelectric generation. The report can be found here: https://researchspace.auckland.ac.nz/handle/2292/12555

Box 12.1 Emissions from geothermal generation

Geothermal energy, a renewable source, generates a significant and growing proportion of New Zealand's electricity. Yet using geothermal fluids to generate energy causes "fugitive" CO2 and CH4 emissions. The emissions depend both on the technology used and on field chemistry. The emissions intensity of New Zealand's most intensely emitting geothermal plant (Ngawha) is higher than that of a low-efficiency gas plant. Even so, six of New Zealand's seven plants have substantially lower emissions than high-efficiency gas plants. The volume-weighted average emissions intensity across all plants is approximately a quarter of that of gas.

In fact, the Ngawha plant exhibits a progressively declining Unique Emissions Factor, which at 10 March 2017 was gazetted as 0.08469 tonnes of CO2/tonnes of steam. It is no longer correct that Ngawha has higher emissions than a low-efficiency gas plant. In addition, Rotokawa and some other geothermal systems are also exhibiting a reduction in overall emissions as they undergoes a degassing process in response to development. In short, geothermal overall is a low emission source of electricity.

The following graph, created from data obtained by NZGA from MBIE shows the relative emissions from geothermal, coal, and natural gas sources of electrical power.



Number of NZ Geothermal Electricity Plants.

On page 326, Box 12.1 states:

> Box 12.1 Emissions from geothermal generation
> Geothermal energy, a renewable source, generates a significant and growing proportion of New Zealand's electricity. Yet using geothermal fluids to generate energy causes "fugitive" CO2 and CH4 emissions. The emissions depend both on the technology used and on field chemistry. The emissions intensity of New Zealand's most intensely emitting geothermal plant (Ngawha) is higher than that of a low-efficiency gas plant. Even so, six of New Zealand's seven plants have substantially lower emissions than high-efficiency gas plants. The volume-weighted average emissions intensity across all plants is approximately a quarter of that of gas.

There are seven geothermal systems under development but that is not the same as seven power plants, as several systems have more than one station on them. Carey *et al.* 2015 provides a table of New Zealand geothermal power station. The report can be accessed here: https://www.geothermal-energy.org/pdf/IGAstandard/WGC/2015/01052.pdf
This report identifies each individual facility, although often some of them are grouped together as one station, for example the Wairakei Binary Plant is considered part of the Wairakei Power Station. Grouping adjacent stations that are connected with each other gives a total of 16 power plants.

Switching stations on and off:

On page 330 it states:

> I. G. Mason et al. (2013) investigate the technical feasibility of eliminating all thermal plant from New Zealand's electricity system, while maintaining resource adequacy under conditions that pertained in recent years. Their full model uses a combination of wind, pumped hydro and over 600 MW of geothermal generation, which is switched on and off to manage the variation in generating inflows (and, implicitly, in demand). Without the use of pumped hydro, which has a high capital cost and is probably environmentally and economically infeasible, Mason et al.'s model achieves 99.8% renewable generation.

It is possible for a geothermal power station to be run at a variable output according to demand. This is known as 'load following' and is not the same as switching a power station on and off, which is normally only done once a year for maintenance. There are multiple significant technical issues with effects on plant, steam pipelines, wells and underground aquifers from starting and ceasing flow, and it is not feasible to switch a geothermal plant on and off daily. Cooling and reheating of the kilometres of pipe and the station equipment can cause problems of metal contraction and expansion. Well flow characteristics can change and some wells may cease to flow.

Load following by a geothermal power station is not currently done in NZ and we cannot foresee a situation where it is likely to happen. We consider your report would more accurately reflect current reality and possibilities if it referred to load following rather than switching on and off, and rewrote your scenario analysis to acknowledge that load following is an unlikely scenario for geothermal power stations.

Is Geothermal a Renewable Resource?

Throughout most of the document, geothermal energy is referred to as a renewable resource, in line with its definition as such in the Resource Management Act 1991, S2. For example, page 7 states:

> An efficient and well-functioning electricity system will play a central part in the transition to a low-emissions economy. New Zealand's largely decarbonised electricity sector is a major advantage, and considerable scope exists to further increase the supply of electricity from renewable sources, such as wind (the cost of which has been falling rapidly) and geothermal energy (which still produces some emissions). This will create opportunities elsewhere in the economy to replace the use of more emissions-intensive energy sources.

However, page 346 states:

> New Zealand already has 85% of its electricity generated from mostly low-emissions renewable sources. In the longer term, new technology should enable even more electricity to be generated at

> reasonable cost from low-emissions sources even as electrification of transport and industrial heat push up demand. Yet providing on-call generation to meet peaks in demand, and most importantly to provide energy in dry years, will remain a challenge. Under current technology, assigning this on-call role to non-renewable sources such as geothermal generation will cause a substantial rise in electricity prices. The Government should be cautious about setting stringent targets for electricity sector emissions before technology becomes available to further reduce emissions at reasonable cost.

Since geothermal energy is defined as renewable by statute, this and any other reference to geothermal energy as non-renewable need to be corrected.

East Waikato Council(s)?

On page 370, a paragraph states:

> Some examples of this exist. For example, Auckland, Christchurch City and East Waikato Councils discuss climate change in their WMMPs, while in Wellington Region's WMMP (2017), Hutt City Council identifies a number of goals in the explicit context of reducing emissions. Those goals include reporting on its own emissions, supporting household composting to reduce emissions, and reducing waste to landfill relative to GDP; and also to reduce emissions. However, in general, this avenue to address emissions is circuitous, and offers limited concrete direction to territorial authorities for reducing waste emissions in their jurisdiction.

There is no local government body called East Waikato Council, whether Regional, City, or District. It would help if the identity of this body could be clarified.

Geothermal technical input to the report

For information regarding the operation of geothermal power stations, the report seems to rely heavily on Stevenson et al. 2018:

> Stevenson, T., Batstone, S., Reeve, D., Poynton, M., & Comendant, C. (2018). Transition to zero net emissions by 2050: Moving to a very low-emissions electricity system in New Zealand. Wellington: New Zealand Productivity Commission. Available at http://www.productivitycommission.govt.nz/low-emissions/draftreport

Stevenson *et al.* rely heavily on Mason *et al. 2013* for detail.

> Mason, I. G., Page, S. C., & Williamson, A. G. (2013). Security of supply, energy spillage control and peaking options within a 100% renewable electricity system for New Zealand. Energy Policy, 60, 324-333.

However, neither Stevenson *et al.* or Mason *et al.* provide strong evidence to support their statistics and claims in relation to geothermal matters. The NZGA includes in its membership many world-renowned geothermal energy consultants and experts whom the commission could call upon to ensure completeness and accuracy in respect of geothermal matters. Assistance may be sought from our member companies, details for which are available on our website, or by application to the NZGA President.

Reference to a NZGA communication

There is a reference to a NZGA source in the Reference Section, but it lacks sufficient detail for anyone to know what the source document or comment or email or webpage is:

> New Zealand Geothermal Association. (2018). Geothermal Emissions. Napier: New Zealand Geothermal Association.

It would be helpful to the reader for the nature of this reference to be clarified. We suspect that it may be to http://nzgeothermal.org.nz/emissions/ .

Conclusion

Once again, we thank you for the opportunity to submit on the report, which does an admirable job of examining the policy levers in place to manage annual greenhouse emissions from human activities and in attempting, through economic modelling, to measure how effective the carbon market will be in meeting NZ's international commitments and to assess alternative policy mechanisms.

New Zealand's abundant and low-carbon geothermal energy source, for both electricity and direct heat applications, is well-placed to help New Zealand meet its domestic energy requirements and international commitments.

We would be happy to answer any further queries.

Yours faithfully

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