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Taheke Geothermal Project

Economic assessment for fast-track consenting

NZIER report to Eastland Generation

24 November 2022

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Key points

The Taheke Geothermal Development is a geothermal power station with net capacity of 35MW capable of generating around 294 GWh per year, located at Okere Falls in Rotorua Lakes District. It is being proposed by the ROOPU Whakarite Mahi Limited Partnership formed between Eastland Generation Limited, Taheke 8C and Adjoining Land Blocks Incorporated.

If consented, the partnership will bear the costs of constructing the power station in expectation of earning a return on its investment from the revenues from the sale of its electricity, either from contracted customers or from participation in the wholesale electricity market. The Māori owners of the Taheke 8C and Adjoining Land Blocks Incorporated will receive rent from the lease of the land and dividends from the profits of the operation after its debt is reduced. Those can be used to fund longer-term economic development for their people through investment in training and job-creating ventures.

Rotorua District has seen its economic activity contract through the COVID-19 pandemic, largely due to the border shutdowns and loss of tourism revenue to the District. Tourism spending in Rotorua almost halved between 2019 and 2021, and tourism's contribution to Rotorua District's gross domestic product fell from about 11% to 6% over the same period.

The Taheke proposal is a 'shovel-ready' project that can be swiftly brought on stream to provide spending and employment to help the District's recovery from COVID-19. It contributes to various objectives identified in section 19 of the COVID-19 Recovery (Fast-track Consenting) Act 2020 and warrants consideration under the Act for providing:

- Economic benefits for people and industries in the region affected by COVID-19, through employment generation and flow-on effects, mostly in the construction phase.
- A source of power and local employment to support social and cultural wellbeing for current and future generations for decades to come.
- Ability to progress the project faster than would otherwise be the case, bringing those benefits forward into the near-term post-COVID recovery period.

The Taheke Geothermal Project will require a range of jobs in its construction stage, including relatively unskilled labourers who could be people from other industries who lost their jobs due to COVID-19. Staff specialised in geothermal development are more likely to come from Kawerau, which is still part of the broader Bay of Plenty Region and with employment challenges of its own.

The Taheke Power Station would add 3% to New Zealand's geothermal generation capacity and 4% to its annual geothermal generation, contributing to reducing greenhouse gas emissions and helping New Zealand's efforts to mitigate climate change and transition more quickly to a low emissions economy. Locating in an area where electricity demand exceeds generation capacity improves electricity supply by reducing transmission losses. It also improves resilience by providing a source of renewable power that is less affected by meteorological hazards of climate change than other forms of renewable generation.

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1 Introduction

This report provides an economic assessment of the Taheke Geothermal Development being proposed by the ROOPU Whakarite Mahi Limited Partnership (a partnership between Eastland Generation Limited and Taheke 8C and Adjoining Land Blocks Incorporated). The partnership is seeking an application for consents under the COVID-19 (Fast-track Consenting) Act 2020, and this report has been prepared in accordance with that Act.

This report is structured around:

- Outline of economic assessments under the Resource Management Act 1991 (RMA) and the requirements of the COVID-19 (Fast-track consenting) Act 2020
- Description of the proposed Taheke Development
- Existing economic environment around the Taheke field
- Economic impact analysis of the proposed Taheke development
- Economic benefits of the proposed Taheke development
- Assessment against the COVID-19 (Fast-track Consenting) Act 2020 requirements
- Conclusions.

1.1 Economic assessment under the RMA

Economics, in its broadest sense, is the study of how limited resources are used in satisfaction of potentially unlimited needs and wants. Economic assessments can both indicate the likely economic consequences of proposals and inform the choices made under the RMA on consenting and regulatory conditions placed on activities.

The purpose of the RMA is to promote the sustainable management of natural and physical resources, defined in section 5 as managing the use, development and protection of natural and physical resources in a manner which enables people and communities to provide for their social, economic and cultural well-being while sustaining physical resources to meet foreseeable needs, safeguard life-supporting capacities of the environment and avoid, remedy or mitigate adverse effects of activities on the environment.

Explicit recognition of economic considerations under the RMA includes section 5's references to enabling communities to provide for their economic wellbeing and section 7(b)'s requirement to have regard to efficient use and development of natural and physical resources.

Economic assessment under the Act usually centres on two forms of analysis. One form is an economic impact analysis (**EIA**) of the effect of new spending, jobs and incomes injected into an economy by a new activity, including the stimulus to productivity given to other businesses in the economy that either supply the new activity or meet new demands created by enhanced incomes created by the activity. The other form is cost-benefit analysis (**CBA**) which estimates the gain in net economic surplus across the economy arising from the investment in a new activity, such as by harnessing a hitherto unutilised source of geothermal heat to create new value from electricity generation.

Both these assessment forms look beyond a proposed activity or project to impacts on the wider economy and environment. As a proposed project would not proceed unless its proponents expected it to be a positive private return on their own invested resources, the RMA is primarily concerned with effects external to the private decision process. The economic assessments take into account 'public' effects external to the proponents to give an assessment of the proposal's overall effects on the environment, which the Act defines broadly to include social, economic and cultural conditions. A CBA, in particular, can be structured to estimate a community-wide 'social' return on the investment being made.

1.2 Economic criteria under the COVID-19 (Fast-track Consenting) Act 2020

The COVID-19 Recovery (Fast-Track Consenting) Act 2020 (**CRA**) added an extra layer of criteria for considering whether a project helps achieve the purpose of the CRA, which is "to urgently promote employment to support New Zealand's recovery from the economic and social impacts of COVID-19 and to support the certainty of ongoing investment across New Zealand while continuing to promote the sustainable management of natural and physical resources".[1]

These criteria include the project's economic benefits and costs for people and industries affected by COVID-19, the project's effect on the social and cultural wellbeing of current and future generations, and whether the project will progress faster by using the processes of the CRA. There are also more specific criteria about the project's public benefit in such matters as generating employment, providing infrastructure to improve economic and environmental outcomes, contributing to efforts to mitigate climate change and building resilience against changing climate hazards.

1.3 Outline of the proposed Taheke project

This proposal is to develop a geothermal power station drawing fluid from the Taheke geothermal field near Okere Falls in Rotorua Lakes District. The proposed site is 2 km from Okere Village, 18 km from Rotorua, and 40 km from Kawerau, where some of the technical staff and contractors skilled in geothermal plant operation are likely to be drawn.

Fluid is proposed to be abstracted at a rate of 3.65 megatonnes per annum with an average daily extraction of up to 10,000 tonnes. The expected nominal output is in the range of 25–40 MWe net of energy used to operate the power station. Final decisions on the generation method and equipment have still to be finalised, pending further on-site examination.

Three wells would be drilled on the site. After a year's drilling, construction is expected to take 24 months until commissioning. The company is currently considering two options for connecting to the National Grid: a recently upgraded 220kV line or a 110kV line. Either connection would allow the export of power for participation in the Wholesale Electricity Market (**WEM**) or direct supply to customers on off-market supply contracts.

Assuming a mid-range net output of 35 MW and 96% utilisation, the Taheke power station could generate around 294 GWh per year.[2] Other things held constant, this could increase New Zealand's annual geothermal electricity generation by 3.7% and increase total annual electricity generation in New Zealand by 0.7%, compared to 2021 annual generation, as

1 https://www.legislation.govt.nz/act/public/2020/0035/latest/LMS345544.html

2 Net output is the generation available for sale, after deducting electricity used in running the power station; utilisation is the percentage of days in the year the plant can operate, excluding stoppages for maintenance and repairs.

shown in Table 1 below. The Taheke power station also directly increases New Zealand's peak capacity by 0.4 percent and provides generation in shoulder periods, allowing hydro storage capacity to be conserved for peak periods and supporting generation in dry years.

Table 1 Current generation across New Zealand

Year ending December 2021 for estimated capacity and net generation

Generation type	Generation capacity[1]				Net generation			
	2020 MW	2020 Share	2021 MW	2021 Share	2020 GWh	2020 Share	2021 GWh	2021 Share
Hydro	5,443	56%	5,444	55%	24,024	56%	23,992	55%
Geothermal	1,035	11%	1,035	10%	7,834	18%	7,968	18%
Biogas	33	0%	34	0%	271	1%	265	1%
Wood[2]					460	1%	483	1%
Wind	690	7%	913	9%	2,282	5%	2,616	6%
Solar[3]	144	1%	188	2%	159	0%	203	0%
Oil	191	2%	191	2%	13	0%	26	0%
Coal	500	5%	500	5%	2,159	5%	3,020	7%
Gas	1,230	13%	1,230	12%	5,932	14%	4,650	11%
Co-generation	416	4%	416	4%				
Waste Heat					40	0%	43	0%
Totals	**9,538**	**100%**	**9,763**	**100%**	**43,173**	**100%**	**43,267**	**100%**

Note:

1 Generation capacity for 2021 for all types except solar, is reported by MBIE.

2 Generation capacity that uses wood as a fuel is not listed in Table 7 of the MBIE report.

3 Solar generation capacity data is primarily distributed small scale generation -146 MW of the 188 MW of capacity at the end of 2021 was made of generation units with capacity less than 10 kW.

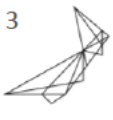
Source: 'Energy in New Zealand 2022' published 18 August 2022 Electricity Graphs and Data Tables, spreadsheet Tables 1 & 7. Electricity Authority data for distributed solar generation.

2 Economic impact analysis of Taheke geothermal project

The proposed Taheke development is within the territorial authority of Rotorua Lakes District Council, and it will affect both the economy of the District and the wider Bay of Plenty Region. It will also add to national electricity generation capacity and affect the national economy, although much smaller proportionately than at the regional and local levels, as project impacts are proportionately larger the smaller the jurisdiction.

2.1 The existing economic environment around the Taheke area

In recent years the Bay of Plenty has seen the fastest growth in gross domestic product (GDP) of all regions in New Zealand, built on strong markets for primary and processed products from industries such as dairying, horticulture and forestry, as well as increased



shipping of containers and general merchandise through the port of Tauranga, New Zealand's largest port in volume terms. But general prosperity masks wide variation within the region. The most prosperous areas are in Tauranga and Western Bay of Plenty, which have attracted population and investment for retirement living as well as for businesses around the port and rural industry support services. Conditions are less favourable in the Eastern Bay of Plenty, and the Rotorua District falls between these two extremes.

Table 2 shows that Rotorua's share of national GDP is proportionately smaller than its share of the population, and its GDP per capita is smaller than the average for the Bay of Plenty Region and New Zealand. Nevertheless, Rotorua achieved a positive annual average growth rate for the 10 years up to 2021, built around primary production and the growth in tourism over that period. With the impact of COVID-19 and the precautionary restrictions such as border closures, its economy shrank between 2020 and 2021 by more than the national average, while that of the Bay of Plenty region as a whole continued to experience positive growth.

Table 2 Regional economic characteristics – 2021

	Units	Rotorua	Bay of Plenty	New Zealand
Population in 2021	#	77,400	340,800	5,105,100
Share of population		1.5%	6.7%	100.0%
Gross Domestic Product	$m	3,825	19,319	326,507
Share of GDP		1.2%	5.9%	100.0%
GDP per capita	$/head	49,419	56,687	63,957
Share of GDP/capita		77.3%	88.6%	100.0%
Average annual growth in total GDP 2011-2021		1.7%	2.1%	2.6%
Annual growth 2020-2021		-2.9%	2.0%	-1.2%

Source: Statistics New Zealand Regional GDP YEM 2021; Infometrics Economic Profile Rotorua

Compared to the New Zealand average, Rotorua's economic structure has proportionately higher shares of activity and employment in forestry and logging, wood product manufacturing, accommodation and food services, dairy farming, road transport and agricultural support services. It has proportionately lower shares of activity and employment in professional, scientific and technical services, finance, telecommunication services, wholesale trade and mining. It is also lighter in electricity and gas supply services than neighbouring Kawerau, where a greater concentration of geothermal electricity generation plant supports a larger pool of employees with the skills used by this industry.

Tourism, which comprises parts of the accommodation and hospitality, retail, transport, arts and cultural services sectors that are used *in situ* by visitors to the District (both foreign and domestic tourists), accounted for 11% of Rotorua District's GDP in 2019, compared to about 4.6% of GDP nationwide. In 2021, with COVID-related border restrictions excluding almost all foreign tourists, tourism's share of GDP had shrunk (by 46%) to 6.2% in Rotorua District and (by 42%) to 2.8% in all New Zealand. While there was some rise in domestic

tourism by New Zealanders precluded from overseas travel in this period, many tourism businesses had a lean time and could not support as many employees as in previous years. This contributed to Rotorua's employment shrinking by 2.9% between 2020 and 2021 after seven previous years of continuous growth.

A report by the Ministry of Business Innovation and Employment to a Bay of Plenty Regional Leadership Group identified a range of factors that would make recovery from COVID-19 disruptions challenging for the region, exacerbated by sub-regional variation in job losses.[3] These included:

- Bay of Plenty has higher unemployment and lower household incomes than the national average
- Tourism-dependent areas like Rotorua faced greater job loss than more diverse areas
- Māori, youth and women were particularly hard hit by their greater presence in tourism-reliant hospitality and retail sectors
- Business uncertainty had caused a shift towards greater reliance on casual and fixed-term workers with fewer opportunities for permanent employment
- Existing skills shortages were exacerbated by border closures and the inability to access permanent or temporary workers from abroad
- Forestry and wood processing increased mechanisation of their operations to counter worker scarcity, creating fewer opportunities for long-term post-COVID employment
- Shovel-ready construction projects have absorbed some locals facing 'redeployment' by COVID-related lay-offs.

New projects such as the Taheke geothermal development aid economic recovery from COVID-19 disruption by creating new demand for labour in the locality, payment of wages in the District, and new spending on goods and services from local suppliers, all of which help to increase incomes and well-being in the locality. Labour requirements may not be a perfect match for the skills of people who have lost their jobs from COVID disruption, but there will be opportunities for people to adapt to new jobs and acquire new skills and experience that will increase their resilience against future changes.

2.2 Direct expenditures and employment from the Taheke project

The Taheke Geothermal Project is expected to cost around s 9(2)(b)(ii) over several years, with construction concentrated over a three-year period. Excluding around s 9(2)(b)(ii) spent on generation and other electrical equipment that will be mostly imported, it will inject around s 9(2)(b)(ii) of capital investment into the local economy, much of it going to local suppliers of materials, services and labour, supporting business and wellbeing in the local economy.

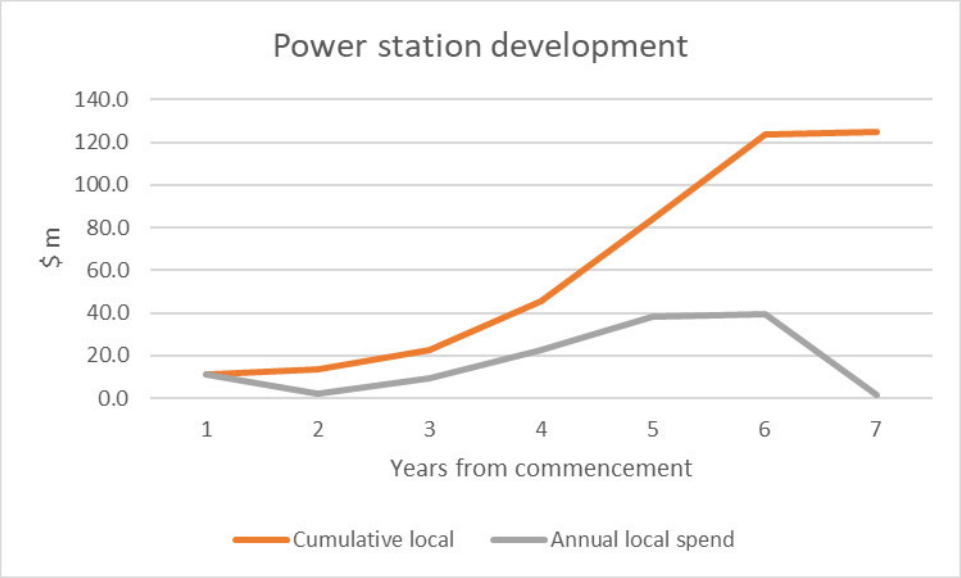
Figure 1 shows the timeframe of capital spending on the project, covering just the money spent locally on the project (excluding imported components). The main construction occurs after three years of preliminary work, including consenting and consultation. This implies that the main employment on the project will not occur until 2024–2026.

[3] https://www.mbie.govt.nz/dmsdocument/17895-bay-of-plenty-regional-labour-market-and-socio-economic-profile

[4] Approximately s 9(2)(b)(ii) of this expenditure has already been completed, on drilling an exploration well.

Compressing the consenting preliminaries under the CRA will shift the main employment earlier to where it will provide a greater contribution to post-COVID economic revival.

Figure 1 Timeframe of annual capital spending on the project



Source: NZIER

Internationally, geothermal power stations require about 3.1 full-time equivalent jobs per MW installed,[5] which would require approximately 120 FTE[6] jobs during construction, spread over five years remaining of power station construction until commissioning, after preliminary work on obtaining consents, refining design and installing civil works. Jobs would peak in years 4 to 6 in the graph (2024-2026 in the current planned timeline).

The total operation and maintenance cost for the power station is estimated at s 9(2)(b)(ii) s 9(2)(b)(ii) , of which about s 9(2)(b)(ii) is expected to be spent with local suppliers.[7]

Once the power station is commissioned, there will be direct employment of four operational staff (4 FTEs), with up to 30 contract roles to support activities like site security, ongoing maintenance, cleaning and transportation of supplies. About 20 of those contractor jobs will be for a two week maintenance shut-down each year, equivalent to about 0.9 FTEs. The remaining 10 will not be full time but in total amount to around 5 FTEs. Wages to local staff and payments for contract services will be the principal means of continued injection of funding into the local economy.

5 Geothermal Energy Association (2014) https://www.ourenergypolicy.org/resources/the-economic-costs-and-benefits-of-geothermal-power/

6 A full time equivalent (FTE) job is calculated on an annual basis, assuming 8 hours a day, 5 days a week for 46 weeks (excluding four weeks leave and two weeks public holidays), totalling 1840 hours per year.

7 This assumes the allocation of operation and maintenance expenditure between 'local' and 'imported' spending will be the same as the allocation for the construction of the power station.

Providing jobs and incomes to the region provides social as well as economic benefits. A report commissioned by the Ministry for Primary Industries[8] found that creating and sustaining jobs in the regions:

- provides money, boosts living standards and wards off poverty
- improves health and access to health care for workers and their families
- provides social contact and contributes to social cohesion
- contributes to people's life satisfaction and sense of identity.

Conversely, without jobs, there would be less money, a lower standard of living, less ability to sustain health and social services that increase the security of people's lives, and less social cohesion. More people are likely to leave the District in search of better jobs.

2.3 Indirect flow-on effects of the Taheke project

Those economic impacts described above inject spending and jobs into the local economy, but they also stimulate wider 'flow-on' impacts across the local economy. These arise from:

- Indirect positive impacts on local suppliers of inputs to the project, for whom the new demand increases the profitability of businesses, productivity of assets, and in the case of labour enhances incomes through higher paid work than alternatives in the local market.
- Induced positive impacts on local businesses who face increased demand for their goods and services due to enhanced incomes of those involved directly or indirectly on the project.

Indirect and induced effects are commonly illustrated by economic 'multipliers' based on inter-industry models of the economy using input-output methodologies. A multiplier derived from such models is applied to the direct impact to estimate the total impact of a project across all sectors in the economy, according to the trading of inputs and outputs between sectors in the model. However, multiplier methodologies typically over-state the total economic impacts of new projects because they assume that economic resources such as land, labour and capital are infinitely available, are never idle or can be reallocated without adjustment costs. They are based on static input-output models and assume that if new spending is injected into one sector (like geothermal power plant construction), there are sufficient free resources in the economy to be costlessly transferred to support that development without consequence for the rest of the economy.

In reality, there are usually few free or unutilised resources in an economy, so when new projects increase demands for certain types of inputs and labour that face constraints on supply, they raise their price and increase their costs for all sectors that are using or may want to use those same inputs. So, while a new project stimulates new business in the local economy, some existing businesses face higher input costs, reducing their profitability and capacity to reinvest. While input resources are transferred to their higher-valued uses, other existing activities face reduced access to those inputs and possible contraction.

The result is that whereas multipliers based on input-output methodologies are commonly encountered in the range of 2–3 times the direct impact or sometimes even higher, actual impacts are more likely to be in the range of 1.5 to 2 times the direct impact. This can be

[8] Quigley, R. and Baines, J. (2014) *The social value of a job*. Wellington: Ministry for Primary Industries.

shown using computable general equilibrium (CGE) modelling, which builds on the input-output models of inter-industry transactions to account for changes in prices of inputs and outputs in response to new demands and allows for input resources to reallocate to other sectors in response to changes in the value of inputs in different sectors. CGE models are widely considered to give more realistic impact estimates than multiplier methodologies.[9]

CGE models need to be tailored to the characteristics of a particular local economy and the nature of the new investment that is being considered. While NZIER has such a model that can be configured to examine particular regional impacts, time constraints have precluded its use in support of this current assessment. [10]

A report by Concept consulting on the Geofuture's project on the Wairakei Geothermal Field used a regional multiplier of 2.13 to represent the flow on effects of FTEs from geothermal construction, covering only indirect not induced effects.[11] Applying that to the Taheke Geothermal Development raises the FTE total associated with Taheke development construction phase to 255 over 5 years, as shown in Table 3.

Table 3 Employment consequences of Taheke development

Full Time Equivalents per year

	2023	2024	2025	2026	2027	Total
Construction FTE						
Direct	10.1	24.4	41.4	42.4	1.6	**120.0**
Indirect	11.4	27.5	46.8	48.0	1.8	**135.6**
Total FTE impact	**21.5**	**51.9**	**88.3**	**90.4**	**3.4**	**255.5**
Post construction FTE						
Operations staff						**4.0**
Sundry contractors						**5.0**
R&M contractors						**0.9**
Total direct FTE						**9.9**
Indirect FTE						**11.2**
Total FTE impact						**21.0**

Source: NZIER, drawing on Concept Consulting

[9] See Gretton, P. (2013) *On Input-output Tables: uses and abuses*. Australian Productivity Commission Staff Research Note for a thorough discussion of what multipliers are, how they are constructed and their shortcomings as tools for assessing economic impacts.

We also note that the Australian Bureau of Statistics has ceased to provide multiplier estimates from its input output tables. http://www.abs.gov.au/ausstats/abs@.nsf/Previousproducts/5209.0.55.001Main%20Features4Final%20release%202006-07%20tables?opendocument&tabname=Summary&prodno=5209.0.55.001&issue=Final%20release%202006-07%20tables&num=&view=

[10] Multipliers vary by industry and with the local economy in which they are calculated: large economies have higher multipliers than small ones where spending leaks out of the economy on imported supplies.

[11] Concept Consulting (2021) GeoFuture project: economic benefit assessment, attached as 'Appendix 5 - Economic Benefit Assessment' https://online.taupo.govt.nz/online-services/REF210812486/files/2okxhy7hBeLuFOhQ7K2XKllZ64adMrkQeIzyOBrzM2ok

A multiplier of 2.13 is towards the high end of the range of implicit multipliers commonly obtained from CGE modelling. With a lower multiplier of 1.65, the total FTE count after addition of indirect impacts would be about 200, rather than 255. Induced effects would raise both these low and high estimates by an indeterminate amount, as we have found no existing estimates of induced impacts specific to geothermal developments. Induced impacts are however generally smaller than the indirect impacts.

Applying the same multipliers to post construction FTE of about 10 would add 11 FTE at the high estimate for a total of 21 FTE or add 7 FTE at the low estimate for a total of 17 for each year the power station is in operation, other things held constant. These estimates are not precise but give an order of magnitude of the likely indirect impacts.

3 Economic benefit from the provision of low emission energy

While economic impacts often command attention when considering new developments, they are not the only economic consequence of a new geothermal power station. Another consequence without which there would be no impacts comes from harnessing the natural resources of the subterranean environment to produce something of value, electricity.

3.1 Planning provisions and strategic fit

The proposed development will be located primarily in the Taheke 8C Development Area, as defined in the Rotorua Lakes District Plan, and there may also be some future work in the adjacent Whangamoa Development Area. The plan's vision for the Taheke area is the development of geothermal energy production with a number of appropriate direct and cascade uses.

It is also located in Geothermal Management Group 3 under the Bay of Plenty Regional Natural Resources Plan, which implements the Bay of Plenty Regional Policy Statement. The regional documents describe Group 3 as suitable for "conditional development" and having "potential for development of extractive use (heat or fluid)". They also note that the use and development of the geothermal field is contingent upon the ability to avoid, remedy or mitigate significant adverse effects of development on any Significant Geothermal Features present in those areas.

At the national level, the National Policy Statement on Renewable Energy Generation is broadly supportive of new geothermal electricity generation. Geothermal generation counts as renewable for this purpose, although it may release greenhouse gas emissions at a much lower rate than coal- or gas-fired generation. Such residual emissions can be reduced by capturing and reinjecting the emissions into the geothermal reservoir via a reinjection well.

The Climate Change Response (Zero Carbon) Amendment Act 2019 sets a target of reducing all greenhouse gas emissions (except biogenic methane) to net zero by 2050. Any residual emissions can be offset by carbon sequestration under the terms of this Zero Carbon Act. Principal implications for electricity generation arising from that Act include:

- A government-set target of reaching 100% renewable electricity generation by 2030, which will need to find ways of replacing the current reliance on fossil-fuelled generation to meet peak time demands.

- The need to provide for increasing electricity demand in pursuit of zero carbon,[12] because of both general economic growth and new demands for electricity from the electrification of the light vehicle fleet and replacement of fossil-fuelled industrial boilers by electrical options as indicated in the Government's Emissions Reduction Plan.
- The need to improve resilience against climate change risks to energy supply, such as changes in rainfall and snowmelt on which hydro generation and storage depend.

As a renewable, sustainable low-carbon form of generation, the Taheke geothermal development has a good fit with many of the strategic objectives for energy supply in New Zealand. Geothermal plant can operate continuously with a steady output and are not subject to the intermittency and power swings that may arise with wind farms. They can generate through the night, unlike solar generation. They serve a useful role as a renewable baseload power source.

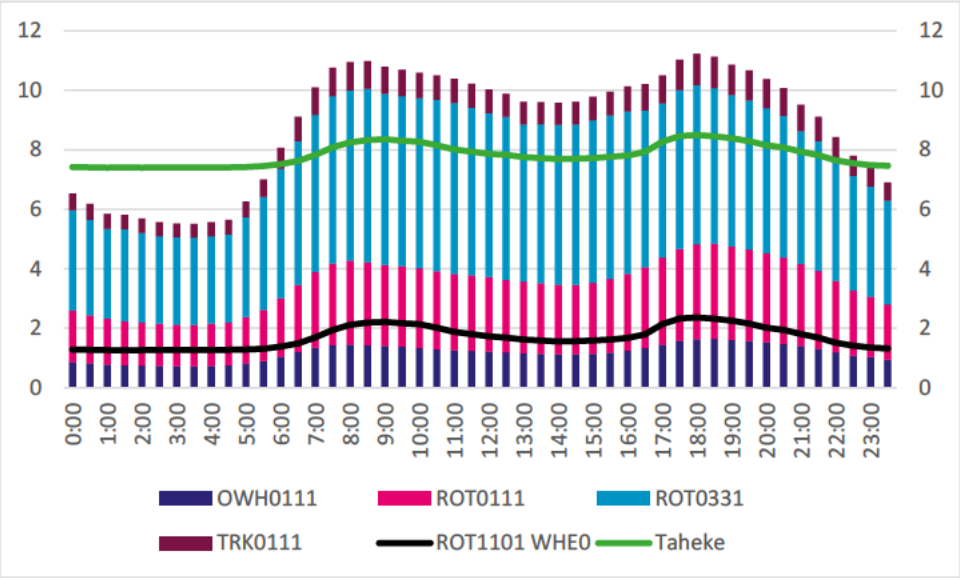
Run continuously to meet baseload demands, geothermal generation can help conserve stored hydro for its more valuable uses in varying despatch to meet peak demands and displace thermal generation at the margin. Geothermal's ability to generate 24 hours of the day enables it to provide power for lower-cost off-peak applications, such as overnight charge-up of electric vehicles. And as a renewable source that doesn't vary with changing meteorological conditions, it adds to resilience against the vagaries of weather. Geothermal generation complements other renewable generation from more variable energy sources, as every additional megawatt of geothermal power may allow the installation of 3 to 5 megawatts of additional intermittent power like solar and wind on the grid.

3.2 Rotorua electricity demand and generation

Total electricity demand in the District was approximately 427 GWh, while total generation was about 82 GWh for the year ended 31 December 2021. (The demand and generation volumes for the year ended 31 December 2020 were almost identical.) The distribution of total demand and generation over half-hour trading periods is shown in Figure 2. The stacked bars show the demand from the four main load grid exit points: two in Rotorua (ROT0111 and ROT0331), Owhata (OWH0111) and Tarukenga (TRK0111). The black line shows embedded generation at Wheo (ROT1101 WHE0). The green line shows existing generation plus the additional generation that would be expected from Taheke.

[12] Transpower's future modelling suggests in three of its five scenarios that new generation capacity in excess of New Zealand's current total capacity will need to be built by 2050 to meet increased demand https://www.transpower.co.nz/sites/default/files/uncontrolled_docs/Transpower_NZGP_Scenarios%20Update_Dec2021.pdf

Figure 2 District electricity demand and generation



Source: NZIER analysis of Electricity Authority volume data

The development of Taheke would significantly reduce the District's dependence on electricity generated outside the District, but the import of electricity would still be required to meet peak demand.

Transpower projections of peak demand[13] for grid exit points in the Bay of Plenty Region indicate peak demand in the District is about 100 MW. The average capacity required to meet the peak evening period demand is about 61 MW.

3.3 Supply of low-cost power

The primary economic benefit of the Taheke geothermal power station will be harnessing geothermal energy to produce electricity.

Electricity is a vital ingredient for modern societies, powering industrial production as well as consumption activities in residential settings. For some uses, such as electronic appliances, there is no substitute, but it is not technically feasible to cost-effectively store electricity in large quantities,[14] so continuous supply is required if disruptive power outages are to be avoided. Too far from other countries to be connected to their reticulated energy infrastructure, New Zealand has to be self-sufficient in its electricity supply. It does this with a mix of generation across both main islands, with a national transmission grid linking generation sources with areas of demand.

Since 1996 electricity in New Zealand has been supplied through a wholesale electricity market, in which different generators offer to supply power for every half-hour period through each day, and Transpower, the system operator, selects the least costly offers to dispatch across the grid to meet demand. Generators are incentivised to offer at low prices

[13] 2021 Transmission Planning Report ‚Transpower', Table 10-1, page 155. The estimate of 100 MW is the sum of the peak demand on the Rotorua 33kv network (49 MW), Rotorua 11kv network (28 MW), Owhata (15 MW) and Tarukenga (8 MW).

[14] Electricity can be stored in batteries at high cost per unit of capacity, although technological improvements are improving their cost effectiveness over time; and generation fuel can be stored for future use, including water in hydro lakes, but that storage capacity is also limited and costly to expand.

that just cover their short run marginal cost in order to be selected, but all dispatched supply is paid for at the price required by the plant last selected for dispatch. Low-cost suppliers like geothermal therefore earn a profit if they offer to supply at the same time as higher-cost generators like thermal plants.

While geothermal power plants may have high capital costs, their operating costs are generally lower than thermal plants as they do not have to buy fuel, if the opportunity cost of geothermal heat for other uses is lower than the value from generating electricity. This gives them advantages over gas- or coal-fired thermal generation, so they can usually bid into the wholesale electricity market at a lower offer price than thermal stations to secure selection for dispatch ahead of the thermal plant.

Genesis Energy operates Huntly (the largest baseload thermal power station in New Zealand) and reports[15] the following for the year ended 30 June 2022:

- Weighted average wholesale electricity price of $160.79 per MWh received for thermal (3,736 GWh), hydro (2,733 GWh) and wind (11 GWh).
- Weighted average fuel costs (including emissions costs[16]) for thermal electricity generation of $95.63 per MWh. (Fixed and variable operations and maintenance costs would need to be added to the fuel cost to calculate the average cost of thermal generation.)

The actual price received depends on the conditions of supply and demand experienced in New Zealand in future years. We do not attempt to forecast future prices here but note that the power station will not be built unless its developers expect a future price path that would enable a positive return on their investment.

The workings of the electricity market mean that geothermal's relatively low cost does not necessarily translate into low prices for consumers but reducing the cost of supply despatched across the system still provides an economic benefit for the country at large. The low short-run cost of renewable generation increases the profitability per unit despatched and generates economic surpluses for the generator companies that can be used to invest in further generation or to pay dividends to company owners in New Zealand.

3.3.1 Meeting peak demand

Rotorua District is in an area where the demand for electricity commonly exceeds the capacity of local generation plant to meet that demand, so power needs to be imported into the area along the national grid. (The peak demand in Rotorua District in 2021 was estimated to be at least 50 MW, while the local generation capacity is nearly zero. There is other generation in the Bay of Plenty region, but the region as a whole is a net importer of electricity during peak periods. The region is also still a net importer of electricity annually, but the deficit has been reduced by the closure of the Norske Skog plant.[17])

[15] 'Genesis Energy Limited FY22 Q4 Performance Report, 22 July 2022; page 6.

[16] Our analysis of the fuel (gas and coal) prices excluding emissions suggest that the allowance for the cost of emissions in the Genesis report is an average of $15.68 per tonne of CO_2e. The estimated average market price for New Zealand Units (NZU) of about $60 over the same period.

[17] The closure of the Norske Skog plant has had less of an impact on the deficit at peak than over the whole year as Norske Skog were managing production to avoid electricity use at peak times.

To the extent that the new power station on the Taheke field supplies power that meets demand in the local area, it reduces the requirement to import power from distant sources and reduces the power lost in transmission over the grid, which on average is about 3.1% of generation despatched. By supplying local demand, the Taheke power station would improve the efficiency of the electricity system by reducing transmission losses and hence also the cost of effective supply across the country, compared to the continuation of the current generation configuration with higher reliance on distance sources and higher cost thermal plant. In addition, the Taheke power station would increase national peak capacity by approximately 0.5 percent – as geothermal power stations operate almost continuously with brief pre-planned shutdowns for maintenance.

3.3.2 Effects on the electricity market

The combined effects on electricity consumers of building a geothermal power station at the Taheke site would be:

- Suppression of power price increases that could arise with 'alternative futures' without the Taheke development
- Avoidance of transmission losses that translate into lower transmission charges across the electricity system
- Reduced probability of supply disruption because the addition of new geothermal capacity near North Island markets increases the diversity of the portfolio of generation plant and reduces reliance on transmission of power from mainly South Island hydro plant
- The cost of the new power station's grid connection and transmission to market will ultimately be borne by consumers, but Taheke's North Island location will make that less than from some other potential generation sites that are more distant from main market demands.

3.4 Effects on employment

Geothermal power plants require a variety of jobs and skills, including welders; mechanics; pipe fitters; plumbers; machinists; electricians; carpenters; construction and drilling equipment operators; surveyors; architects and designers; geologists; hydrologists; electrical, mechanical, and structural engineers; managers; regulatory and environmental consultants; and various back-office staff. While some of these jobs are more likely to come from the pool of specialised geothermal workers in Kawerau than from the displaced workforce in Rotorua, other jobs like construction labourers, security guards, plumbers, and electricians could come from Rotorua.

Most of these jobs will occur in the construction stage of the project. Once commissioned, the power station will be operated by a small team of 4–7 full-time employees, and there will also be in addition 3–5 contractors on site most days in operation, and work for around 30 contractors over the 10 days of annual shut down for maintenance and repairs.

3.4.1 Māori economic development

The Taheke Geothermal Development is a project of a partnership between Eastland Generation Ltd and Taheke 8C and Adjoining Land Blocks Incorporated, a Māori incorporation which owns the land and access to the subsurface geothermal resource and

is also a part owner of the project investment. This will provide the Māori incorporation with a share of the revenues from geothermal electricity sales, from the ground lease for use of the site and access to the geothermal resource. As the initial project debt is repaid, this revenue could support payment of a dividend to the owners or be used to service new debt, which could be used to fund other projects, enlarging choices for the owners.[18]

Utilising the geothermal resource provides the Māori incorporation with an income that it would not otherwise have and which it can use in various ways to enhance the well-being of its members. It could be used to support its members in receiving training to upgrade their skills or to sponsor promising students through higher education. The income could be used for other investments in productive activities, such as using low-grade geothermal heating to support covered horticultural production. Alternatively, it could be used to invest in other enterprises, such as the development of care facilities which has been identified as an opportunity for which the Rotorua District has a comparative advantage that could be developed. The opportunities for direct employment of Māori in the construction or operation of the Taheke Development are only a small part of the potential it provides for economic development in the area. We do not see any negatives for the Māori incorporation from utilising the geothermal resource as proposed.

3.5 Effects on greenhouse gases and transition to a low emissions economy

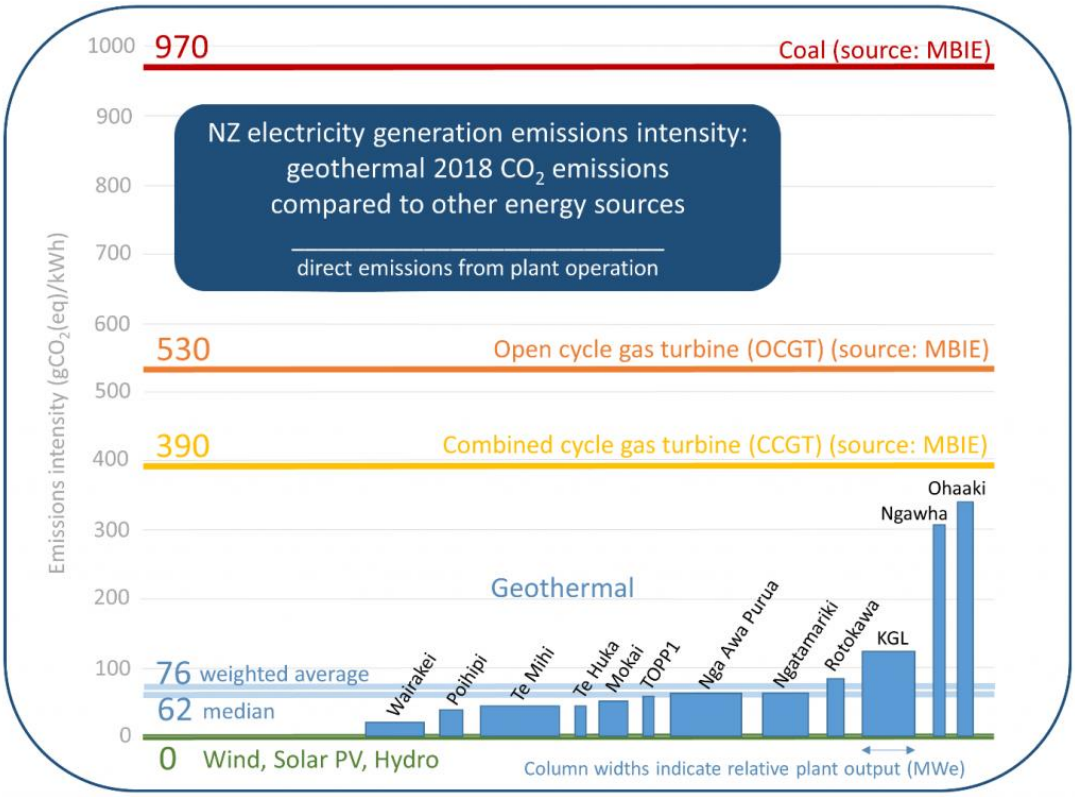
Geothermal electricity generation is not zero carbon generation, but it has much lower carbon emissions than thermal generation alternatives. The amount of greenhouse gas emitted by geothermal generation depends on the characteristics of the geothermal source and the generation process used. While there is some variation across New Zealand's current geothermal power stations, the majority of them have much lower emissions than thermal generation alternatives.

Figure 3 shows that the median and weighted mean emissions of the current geothermal plant are respectively 6% and 8% of emissions from coal-fired generation, 12% and 14% respectively of emissions from open cycle gas turbine generation and 16% and 19% respectively of emissions from combined cycle gas turbine generation. So whenever geothermal generation displaces fossil-fuelled generation, emissions are substantially reduced per MWh.

The maximum CO_2 emissions from the Taheke project is approximately 41 grams of CO_2 per kWh of electricity. This is below the median rate of emissions for geothermal. The developers of the plant are considering the feasibility of technology that will enable the capture and reinjection of the CO_2 emissions, which could lower emissions further toward zero.

[18] The existence of this option has a positive value for the owners.

Figure 3 Greenhouse gas emissions from New Zealand geothermal power stations



Source: New Zealand Geothermal Association

While geothermal generation is used to meet baseload, to the extent this displaces stored hydro from being used for baseload and conserves its storage to displace thermal generation brought in to meet peak demand, geothermal can still contribute to the displacement of thermal peaking plant despite not directly competing at the same time in the market.

The Taheke project will increase the supply of renewable electricity, contributing to New Zealand's efforts to mitigate climate change and transition more quickly to a low-emissions economy. But it also has a role to play in adaptation to climate change that is already in train, strengthening New Zealand's resilience to the effects of climate change. This is because, unlike other renewables such as wind, solar and hydroelectricity generation, geothermal electricity generation is not affected by changing meteorological atmospheric conditions such as increased cloudiness, storms and droughts, which can affect the output of other renewable generation from solar, wind and hydro-plant.

3.6 Other environmental impacts with economic consequences

Apart from avoiding greenhouse gas emissions, the building and operation of a new power station may have other impacts on the natural environment that have economic consequences. These include impacts on land use, impacts on recreation and tourism and general landscape amenity, and other effects such as impacts on biodiversity of vegetation clearance and effects on water clarity and sedimentation from earth movement and other works in preparation of the site and access roads.

The identification and assessment of such effects in RMA processes is usually left to specialists in relevant disciplines, who assess the significance of effects and what conditions or mitigations are required to reduce the residual impacts to minor or less. Economics may have a role in comparing options for mitigation (e.g. between different types of water treatment for managing discharges into the environment) and sometimes in considering whether the mitigation proposed for a project is the most efficient way of achieving the desired outcome (e.g. whether point source discharges should be required to achieve zero discharges where this will have a negligible effect on a problem caused by dispersed non-point discharges). More often, mitigations can be found that do not substantially affect the economic viability of the proposed development and they can be absorbed into the overall costs of the project.

With the proposed Taheke geothermal development, we assume most environmental effects fall into the latter category and can be absorbed in the overall project costs. Impacts on land use are internalised by the involvement of the Māori incorporation and the arrangements it has made with its partners for receipt of lease rents and a share of dividends and in their involvement in the management of any adverse environmental effects that might arise. Of other effects that might spread beyond the property's boundary, unless they have significant effects that warrant significant mitigation, they are unlikely to result in significant economic impact.

4 Conclusions

The Taheke project fits the objectives identified in section 19 of the COVID-19 Recovery (Fast-track Consenting) Act 2020. It warrants consideration under the Act for its role in:

- Economic benefits for people and industries in the region affected by COVID-19, through employment generation and flow-on effects, mostly in the construction phase.
- Providing a source of power and local employment to support social and cultural wellbeing for current and future generations for decades to come.
- Enabling the project to progress faster than would otherwise be the case.

The Taheke geothermal project is located in Rotorua District, an area that has been negatively affected by COVID-19, primarily due to border closures and loss of international tourism visitation. Tourism spending in Rotorua almost halved between 2019 and 2021, and tourism's contribution to Rotorua District's GDP fell from about 11% to 6% over the same period. Employment in tourism-related sectors has fallen in a similar manner.

The Taheke Geothermal Project is a 'shovel-ready' project that can be swiftly brought on stream to provide spending and employment to help the District's recovery from COVID-19. While the employment created is not a close match to the jobs lost in response to COVID-19, it will require a range of skills in its construction stage, from relatively unskilled labourers for general construction work, site security staff to skilled tradesmen such as plumbers and electricians to more specialised staff for geothermal plant construction and operation.

The geothermal specialist staff may come from Kawerau, which although not in the Rotorua District is still part of the broader Bay of Plenty Region facing employment challenges in

recovering from COVID. The project will also provide an income stream for the Māori owners of the site that can be used to fund longer-term economic development for their people through training, skills upgrading, and investment in other job-creating ventures.

By compressing the consenting period, the Fast-Track process can bring forward the substantive spending stages by a year or more to provide more immediate relief.

More particularly, public benefit from the project arises from:

- Generating employment, mainly in the construction phase
- Providing infrastructure that improves economic, employment and environmental outcomes through:
  - Temporary employment stimulus, especially in the short term during construction
  - Longer term supply of electricity at lower cost than some alternatives, hence contributing to the suppression of rising electricity prices that would otherwise occur in the absence of the Taheke development
  - Increasing productivity obtained from New Zealand's geothermal natural resources by bringing another geothermal field into productive use
  - Contribution to reducing greenhouse gas emissions by helping to displace the use of fossil-fuelled thermal generation
- Contributing to New Zealand's efforts to mitigate climate change and transition more quickly to a low emissions economy by inserting more low-carbon emission generation into New Zealand's supply portfolio
- Strengthening environmental, economic and social resilience by providing a source of renewable power that is less affected by meteorological hazards of climate change than other forms of renewable generation.