2024 Annual Aotearoa New Zealand Geothermal Review

Ted Montague [1]*, Craig Stephenson[1], Katie McLean[1], and Sadiq J. Zarrouk[3]

[1] Contact Energy Ltd., Wairakei Power Station, Taupo, New Zealand

[3] Department of Engineering Science and Biomedical Engineering, The University of Auckland, Private Bag 92019, Auckland, New Zealand

*Ted.Montague@contactenergy.co.nz

Keywords: *New Zealand, Aotearoa, geothermal, annual review, 2023.*

ABSTRACT

During 2024, geothermal electricity generation rose 13% to a record 8,741 GWh due to the commissioning of two new power plants at Tauhara Field. Over the year, geothermal generation lifted to 19% of New Zealand's electricity supply. Due to unfavourable hydrological conditions, total renewable generation fell to 85% of national power generation.

The net installed geothermal capacity increased by 17% to 1.207 MWe from 22 power stations in eight fields. Roughly 56% of the capacity is older that 10 years, and the proportion greater than 30 years fell to 16%.

During 2025 generation capacity will likely increase a further 8% with the commissioning of two new binary plants. Ths will boost system reliability and resiliency amid continuing hydro variability. Operators have deferred additional projects in development due to adverse market and detiorating marco economic conditions.

Over the year, operators drilled ten deep conventional wells supporting power generation as well as twelve small diameter wells supporting direct use and resource observation. Drilling activity is expected to relax during 2025 as construction of new capacity wanes.

With the significant increase in generation, the geothermal industry's total CO_2e emissions rose slightly (1.3%) from 2023. However, the downward trend in emissions intensity continues, due in part to ongoing reinjection success at Ngāwhā, Ngā Tamariki, and Te Huka.

Although developers did not commission new high-temperature, direct-use facilities during the year, projects to increase heat use remain in active development.

The services sector continued to evolve with the strengthening of the domestic and international well services sector and the continued success of software services exports.

New Zealand universities continued to support the industry. Geothermal student enrolments at the NZ Geothermal Institute increased with strong support from MFAT Manaaki scholarships. Concurrently, the number of research Masters and PhD enrolments reached a record high.

1. INTRODUCTION

Our sixth annual New Zealand geothermal industry update summaries of geothermal activities during 2024, with emphasis on the surge in power production. Key themes for the year include:

- Geothermal generation rose 13% to a record 8,741 GWh and increased its market share to 19% of national generation;
- Geothermal fleet carbon emissions rose 1.3% despite an 13% increase in generation due to increased NCG re-injection. Fleet emission intensity fell for the fifth consecutive year to 53 gCO_2e/kWh.
- Drilling & completions, testing, and workover activity continue at economically sustainable levels.
- The NZ Government iniatiated a NZ $60 million programme to advance deep geothermal drilling and exploration of super-critical resources.
- Operators are currently constructing 96 MWe of new geothermal capacity. Firms have deferred a further 65 MWe due to commercial conditions.

We wish to acknowledge the perseverance of construction and commissioning staff and contractors during 2024.

2. ENERGY SUPPLY

2.1 Electricity Generation

In 2024, geothermal electrical generation increased 131.5% from 7,732 to 8,741 GWh.[1][2] The increase reflecting the commissioning of the Tauhara (170 MWe) and Te Huka 3 (50 MWe) during the year.

2.2 Contribution to New Zealand Power Supply

Geothermal generation market share increased from 17.8% in 2023 to 19% in 2024. Renewable generation fell from 88% to 86% of system supply despite increases in wind and solar power due to depressed hydro output (Figure 1).

[1] https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/electricity statistics.

[2] Note: MBIE has revised the annual generation statistics for 2023 and 2022.

ISSN 2703-4275

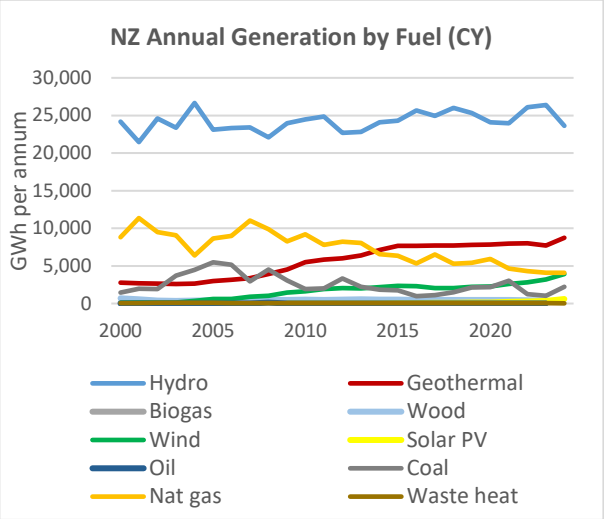

Figure 1: Annual New Zealand Power Generation by Fuel (Sources: MBIE)

2.3 Generation Capacity Changes

Operators commissioned 225 MWe during 2024 (Table 1).

Contact Energy's Tauhara plant features the world's largest single-shaft, triple-flash, geothermal turbine and generator, both manufactured by Fuji Electric. The station runs on 3 pressures of separated steam from a high-temperature (280°C) reservoir. The system is fed by six large-diameter production wells and serviced by 4 reinjection wells.

Table 1: Capacity Commissioned During 2024

Project	Developer	Capacity (MWe)	Type	COD
Tauhara	Contact Energy Ltd.	174	CST-TF	2024
Te Huka U3	Contact Energy Ltd.	51	ORC	2024
Total		225		

Sources: company investor presentations

Contact Energy's Te Huka 3 power station comprises an Ormat steam/brine ORC configuration with a purpose -built extraction and injection system for NGCs.

The new plant shares production and injection facilities with the older Te Huka (26 MWe) station. Contact drilled one new production and one new injection well to supplement the system.

Operators are commissioning a further 95 MWe during 2025 (Table 2). These additions should add another 749 GWh per year. Both developments comprise Ormat ORC plants added to the existing steam supply and reinjection systems.

Table 2 Capacity Commissioning During 2025

Project	Developer	Capacity (MWe)	Type	COD
Ngā Tamariki OEC-5	Mercury NZ Ltd.	46	ORC	2025
TOPP2	Ormat/ Eastland Generation Ltd.	49	ORC	2026
Total		95		

Sources: company investor presentations and press releases

During the year, Contact Energy committed to phase one, re-powering Wairakei Power Station. This will comprise another unit at Te Mihi featuring an Ormat ORC (101 MWe) plant. COD is scheduled for 2027. The existing Wairakei A/B/binary complex is due to close in 2031.

Developers have apparently deferred two projects due to exonomic and power market conditions (Table 3). Both have consents (permits) but remain uncommitted.

Table 3 Capacity Under Development

Project	Developer	Capacity (MWe)	Type	COD
Ngāwhā OEC-5	Top Energy Ltd.	30	ORC	2028 ?
Taheke	T8C Inc.	35	ORC	2029 ?
Total		65		

Sources: company press releases

2.4 Direct Use

National statistics suggest geothermal direct use is slightly declining. To rejuvenate direct use, the NZGA released their fourth Geoheat Action Plan, setting out activities to boost funding for increasing Geoheat use by 7.5 PJs by 2030.

Industrial scale geothermal applications have struggled in recent years as economic conditions have forced the closure of forestry, meat, and dairy processing plants. Nevertheless, several projects made headway.

Paper Machine Conversion

In early 2025, tissue maker Essity completed their geothermal fueled tissue paper machine at Kawerau. This enabled the facility to reduce the mills carbon footprint by 25% Ngati Tuwharatoa Geothermal Assets supplies geothermal steam to the mill.

Food Grade Geothermal CO_2

At Ohaaki Field, Contact Energy and partner are progressing plans to build and operate a food-grade CO_2 plant using the NCGs liberated from the reservoir by the geothermal power plant. The project will supply New Zealand's food, beverage and industrial sectors. The partners will seek FID in 2026.

Business Parks

Both the He Ahi Eco Business Park near Taupo and the Mt Maunganui Industrial Area near Tauranga continued promotions to attract industrial customers to utilise the available geothermal heat resources. During 2024, Tnue's

ISSN 2703-4275

fertilliser plant began operations at He Ahi Eco-Business Park.

3. CARBON EMISSIONS AND REDUCTIONS

3.1 Emissions Performance

As reported by the NZ Geothermal CO_2 Working Group during Geothermal Week in July 2024, Scope 1 emissions (operational emissions) from non-condensable gases (NCGs) were 450 ktCO_2e during calendar year 2024, up 1.3% from 444 ktCO_2e the previous year. The reason for the increase in 2024 is the addition of Tauhara - a major new power station.

Disregarding the new station Tauhara, the total emissions would be 416 ktCO_2e from all the existing power stations, indicating that the declining trend in total emissions continues at -6%. This underlying decline from 2023 to 2024 is attributed largely to the disappearance of Ngāwhā OEC4, with 100% NCG reinjection in place for the whole calendar year reporting period.

Regarding operational emissions intensity, the median is 47 gCO_2e/kWh, and the interquartile range is 23-59 gCO_2e/kWh. The MW-weighted average is 53 gCO_2e/kWh, continuing the big-picture decline of -6% from previous years (Figure 2). The addition of Tauhara does not affect these aggregate emissions intensity statistics, as Tauhara has an emissions intensity very close to the median (48 gCO_2e/kWh).

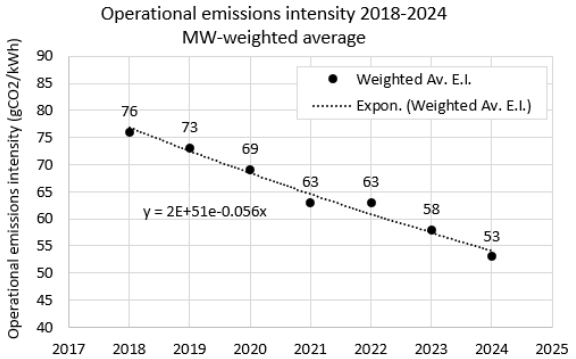

Figure 2: NZ geothermal operational emissions intensity 2018-2024: MW-weighted average.

3.2 Reinjection Schemes

The NZ geothermal industry has a co-operative industry Emissions Working Group, governed by the New Zealand Geothermal Association. This group promotes collaboration and sharing between the geothermal operators to advance emissions reductions from geothermal power stations. The main steps in this direction so far have been the implementation of CO_2 (NCG) reinjection projects at several binary power stations.

Ngāwhā Generation has transformed from having the nation's highest emissions intensity to zero emissions for all 3 stations. The main 2024 improvement is that the new Ngāwhā station (OEC4) recorded zero emissions for the first time, as it operated at 100% NCG reinjection for the whole year. The older Ngawha stations(OEC1-3) remain at zero emissions and 100% reinjection. The combined impact of this is estimated at ~128,000 tCO_2e/year based on pre-reinjection emissions.

Contact Energy's original 100% NCG reinjection project at Te Huka (U1/U2) ran for the whole 2024 calendar year. The emissions were non-zero (4 gCO_2e/kWh) despite the closed-loop system, due simply to difficulties with sampling and matching the NCG volumes going into the reinjection line with those going into the station. Contact's newly commissioned Te Huka station was designed and constructed to accommodate 100% NCG reinjection.

Mercury Energy was the first operator in NZ to implement a NCG reinjection project, at Ngā Tamariki power station in 2021. The original reinjection was 25% of NCG, from one of four OEC units. Work on expansion of this project is underway, with all four units OEC1-4 now capable of reinjecting NCGs, and the current overall level is 40% NCG reinjection.

3.3 Future Developments

Operators plan to expand their NCG reinjection schemes to continuously reduce CO_2e emissions.

Mercury Energy intends to increase the % NCG reinjection at Ngā Tamariki OEC1-4. Also the new OEC5 will be built with NCG reinjection capability, this is under construction and commissioning is expected in FY 2026. The overall target for Ngā Tamariki remains the same - an 80% reduction is emissions from OEC1-5 by 2026.

Mercury is continuing to investigate the feasibility of reinjecting NCGs at the KGL flash plant at Kawerau. This would be the first NCG reinjection project for a flash plant in New Zealand.

Eastland Generation and Ormat are constructing the TOPP2 binary plant with 100% NCG reinjection, based on the Te Huka project. Eastland will then look at retrofitting NCG reinjection to its existing TOPP1, Te Ahi O Maui, and GDL binary plants.

Contact is looking into the feasibility of NCG reinjection for the new Te Mihi 2a binary, and also its flash plants. A decision is expected in 2026 on a food-grade CO_2 capture plant at Ohaaki, which would not remove Contact's emissions liability under the ETS, but move the emissions from Scope 1 to Scope 3 emissions.

Ngāwhā Generation is already at 100% NCG reinjection for all power stations.

As a country, New Zealand carbon emissions continue to fluxuate with hydro lake levels. Dry years have higher carbon emissions as coal substitutes for lower hydro generation. Thermal generation looks to decline as continued investment in geothermal, wind and solar push natural gas-fired capacity off dispatch.

4. DRILLING AND COMPLETIONS ACTIVITY

4.1 Wells Drilled

To support new and existing capacity, field operators drilled ten deep and twelve shallow wells in 2024 (Table 4). Deep activity was split between Kawerau, Rotokawa, and Wairakei Fields. MB Century drilled eitht deep wells; Marokopa Drilling Company drilled two.

4.2 Drilling Trends

Drilling activity hit a 8-year high during 2024 (Figure 3) to support new developments and, to maintain fuelling at Kawerau, Rotokawa, Rotorua, and Wairākei Fields.

Iceland Drilling Company elected to leave the NZ market in 2024, leaving MB Century and Marokopa Drilling (Todd Corp.) as the main geothermal rig contractors.

Annual drilling looks to subside in the near term as new developments at Ngawha and Taheke have been delayed.

ISSN 2703-4275

Table: 4 Calendar 2024 drilling statistics

Field	Deep				Shallow			Total
	APR*	PRD	INJ	OBS	PRD	INJ	OBS	
Ngāwhā	-	-	-	-	-	-	-	0
Rotorua	-	-	-	-	6	2	-	2
Tauranga	-	-	-	-	2	-	2	2
Taheke	-	-	-	-	-	-	-	0
Kawerau	-	2	3	-	-	-	-	1
Rotokawa	-	1	-	-	-	-	-	1
Mokai	-		-	-	-	-	-	1
Ngātamariki	-	-	-	-	-	-	-	0
Wairākei	-	2	2	-	-	-	-	3
Ohaaki	-	-	-	-	-	-	-	0
Tauhara	-	-	-	-	-	-	-	0
Totals	0	5	5	0	8	2	2	22

Sources: press reports, Environment Waikato, Bay of Plenty Regional Council

*Acronyms defined in "Sources, abbreviations and acronyms" section after References.

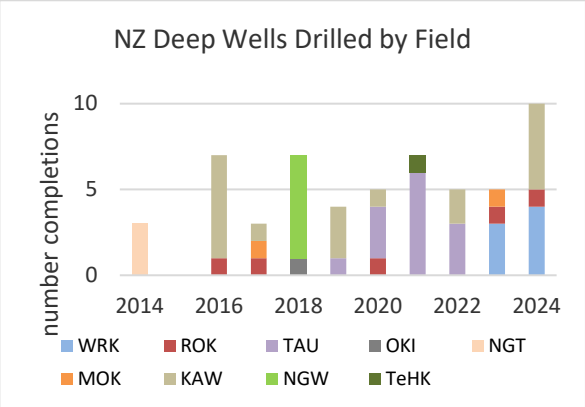

Figure 3: Recent Deep Drilling Activity (Sources: press reports, company annual reports)

5. INDUSTRY STRUCTURING

5.1 New Entries, Mergers, Acquisitions, and Devestments

During 2024 Obayashi Corporation (Japan) finalized the acquisition of a 50% interest in Eastland Generation, including the geothermal plants at Kawerau.

5.3 Regulatory Changes

During the year, the new government passed the Fast Track Approvals Act to accelerate geothermal and other development. The government also introduced the RMA Amendment Bill to stimulate economic growth and productivity. These should speed the permitting of new geothermal developments.

In December 2024, the Ministry for the Environment released its second emissions reduction plan (2026-30). The paper promotes carbon capture, storage (afforestation), continued electricfication, and carbon market reforms.

During the year MFAT began formulating a strategy to lift geothermal development in New Zealand. The strategy will be unveiled at the NZGA seminar in July 2025.

6. SERVICES SECTOR ACTIVITIES

6.1 Software

During 2024, Seequent announced a strategic partnership with the International Geothermal Association for two years. Seequent also continued development of its Workbench packge combining reservoir and surface steam flow modelling for production scheduling.

Meanwhile, the Geothermal Institute at University of Auckland continued to develop and deploy its Waiwera reservoir modelling software as well as modelling work for field operators in Indonesia, USA, Australia and Europe.

Machine learning development and commercialisation continues with Upflow's Gooml based system.

6.2 Technical Services

Technical services growth continued during calendar 2024 across the spectrum of drilling & well services, reservoir services, analytical services, and plant O&M services.

International work provided much of the growth. Assignments in the Philippines included assistance with EDC's drilling campaign (Jacobs), wireline services (MB Century), well condition assessments (Western), well bore modelling and interventions (JRG and Western).

In Indonesia, Jacobs continued engagements as Owner Engineer at Muara Loboh alongside assistance to GeoDipa's Dieng and Patuha expansion projects. Meanwhile, MB Century expanded wireline services and JRG provided binary operating advice to Star Energy.

Activity on the Carribian front (also funded by MFAT) also continued with resource assessments and drilling targeting (JRG).

Solenis NZ also flexed its muscles, providing scaling chemical cleans for clients in Latin America, Iceland, and the Asia Pacific.

Domestically, Western Energy commissioned a heavy-duty coiled tubing unit (CTD) to provide well workover and drilling extension services to complement their existing light CTU services in chemical and mechanical cleaning and lifting.

The Geothermal Institute provided resource assessments and engineering services to clients in New Zealand, Indonesia, Japan and Taiwan. Similarly, analytical services by NZGAL[3] (GNS) continued supplying chemical analysis services to Japan, PNG, Taiwan, Indonesia, and the Philippines.

6.4 Research

It is impossible to detail all the fine research going on. Some highlights follow.

The Geothermal Institute at the University of Auckland continues to support the industry through investigating topical issues such as geothermal CO_2 sequestering (mineralisation of CO_2 underground), mineral extraction from separated geothermal fluids, mineral scaling, and machine learning applications. There is also some significant emphasis on shallow ground-sourced heating research in areas with high energy demand, like Auckland.

The Geothermal Institute has also championed the development (with Pertamina Geothermal Energy) and deployment in 2024 of 2-ha phase flow meters in New Zealand. This represents an important advancement in process control.

Upflow's Xphiles Project moved into the pilot-scale phase. The research seeks to explore the feasibility of using extremophiles to produce protein-rich biomass.

Geothermal Next Generation research, headed by Dr. Isabelle Chambefort, secured a $60 million government grant for a drilling campaign to explore supercritical resources. MBIE seized management control of the project and is currently defining the scope, objectives, and schedule. Upflow leads the associated, innovative Iwi consultation programme.

6.4 Foreign Assistance

MFAT continued its efforts to extend New Zealand's geothermal relationships through assistance. However, 2024 proved to be a slower year for international capacity building.

With changes in spending priorities, MFAT created a new 5-year funding instrument, PINZ, to provide geothermal training to Indonesia. To date, the programme administrator, TetraTech, continues to assess the training needs for future programmes.

Jacobs led MFAT-sponsored training to East Africa and Indonesia. The firm completed two in-country visits to Ethiopia and Tanzania (together with Contact Energy) to assist in drilling and development.

Funding for the East Africa Facility has, on paper, ended. MFAT is considering new arrangements.

6.5 Education & Training

Back in New Zealand, formal academic training (Auckland Uni's Post Graduate Certificate in Geothermal Energy Technology - PGCert) also continued through 2025.

In 2021 the PGCert ran the first fully audio-visual recorded field trip, which made it possible for international students to attend the field trip remotely, observe the field measurement techniques, and apply the field data to their studies. From 2023 Auckland Uni is running in-person classes and field trips for all students.

Figure 4 provides the Geothermal course enrolment numbers, showing the impact of the pandemic on student numbers. The number of enrolments has increased since 2022; with the return of some of the internationally funded scholarship students and the MFAT Manaaki scholarships. There is a significant increase in the number of enquiries and applications in 2025 and numbers have increased by >150 % from those in 2024, getting more than pre-COVID-19 levels. The increase in enrolments in 2025 is also due to a backlog of applications and enrolments during the COVID-19 pandemic years, when students could not make it into New Zealand due to border closures.

PGCertGeothermTech course is more attractive to self-funded professionals upskilling and shifting careers from more conventional energy (e.g. petroleum) to Geothermal Energy. The increase in students numbers in 2025 is a testament to the growth in the geothermal industry.

With the boom in geothermal development, there has been a significant demand for graduates who have been trained in geothermal energy. The New Zealand geothermal industry also has more staff with higher (Masters and PhD) qualifications than at any time before. This allows these companies to undertake research and development projects in-house. Some companies (e.g. Contact Energy Ltd.) sponsor some of their new staff to attend the geothermal PGCert course.

[3] NZ Geothermal Analytical Laboratory

ISSN 2703-4275

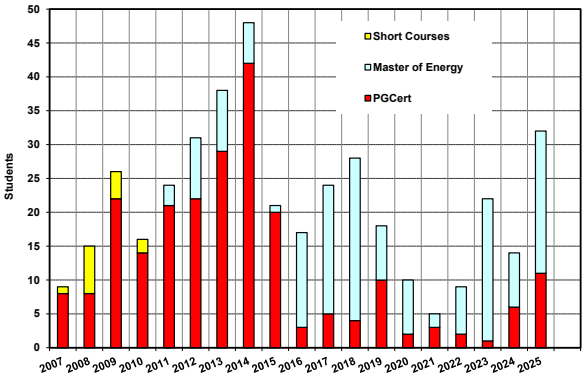

Figure 4: The Geothermal PGCert enrolment numbers since the start of the course in 2007

ACKNOWLEDGEMENTS

We would like to thank all the companies, regional authorities, and individuals who contributed to this paper.

REFERENCES

McLean, K., Richardson, I., Hanik, F., Siega, F. and Gibson, B.(2024): Reducing greenhouse gas emissions from NZ geothermal power stations. *Proceedings 46rd New Zealand Geothermal Workshop.*

SOURCES, ABBREVIATIONS AND ACRONYMS

Statistical Sources:

Electricity Authority Wholesale Market Files (on-line); MBIE Electricity Statistical File; contributions by Contact Energy, Ngāti Tuwharetoa Geothermal Assets, Top Energy, Mercury Energy, Tūaropaki Power, and Eastland Energy.

Well Abbreviations:
PRD production well; **APR** appraisal well; **INJ** injection well; **OBS** observation/monitoring well

Prime Movers:
CST condensing steam turbine**; 1F** single flash**; 2F** double flash; **3F** triple flash**; ORC** organic Rankine cycle (binary plant);

Geothermal Field Abbreviations
WRK – Wairakei; KAW – Kawerau; ROK – Rotokawa; MOK – Mokai; TAU – Tauhara; OKI – Ohaaki; NGW – Ngāwhā; NGT – Ngā Tamariki; TeHK - Taheke

Energy Units:
GWh: gigawatt hours
kWh: kilowatt hours
MW: megawatt
Nm^3 : normal cubic metre (at standard conditions)
g: grams

Currency: unless otherwise indicated, all dollar amounts are in New Zealand Dollars.

Other:
MBIE Ministry of Business Innovation and Employment**; MFAT** Ministry of Foreign Affairs and Trade; **OEM** original equipment manufacturer; **NCG** non-condensable gases (CO_2, CH_4, H_2S, etc.); **FID** final investment decision; **RMA** Resource Management Act; **SAGS** steamfield above ground system; **CTU** coiled tubing unit.