Tuwharetoa Geothermal Kawerau

2020 Community Report Covering Consents to Take and Discharge Geothermal Fluid from the Kawerau Geothermal System (24598 & 66862)

15 SEPTEMBER 2021

Purpose

This Community Report is written in partial fulfilment of the requirements of Resource Consent 66862 (section 17) and the Kawerau System Management Plan (section 7.14.2) to "*inform and update the Community Liaison Group, as well as interested and affected parties and the wider community about the state of the Kawerau Geothermal System on a regular basis.*" The information cited in this report is from reservoir and environmental monitoring results for the calendar year 2020.

Background

Ngati Tuwharetoa Geothermal Assets Ltd. (NTGA) is an iwi-based geothermal energy supplier to the Kawerau Industrial Complex and to geothermal power plants. The Kawerau Industrial Complex is the world's largest industrial geothermal direct use operations, using geothermal steam from the Kawerau geothermal system for various industrial operations. Geothermal steam enables the Kawerau industrial customers to use an indigenous and renewable source of energy, reduce industrial green-house gas (GHG) emissions, and contribute to the decarbonisation of the New Zealand economy.

Resource consents authorise and set the conditions for NTGA's supply of geothermal fluid from the Kawerau geothermal system for the Kawerau Industrial Complex, power generation, and other downstream or cascade uses.

In partial fulfilment of NTGA's responsibilities as a sustainable geothermal operator, consent holder and community member, this community report has been prepared to provide updates on NTGA's activities and to summarise the monitoring and scientific information and reports gathered in 2020.

NTGA's geothermal fluid take from the Kawerau Geothermal System complies with its resource consents

NTGA's geothermal fluid take is limited to a consented volume based on the sustainable take that the Kawerau geothermal system can support.

In 2020, NTGA used around 56% of its consented volume. The consent usage is a small reduction from the previous year, reflecting reduced demand due to the COVID-19 nationwide lockdown and during the TOPP1 upgrade. Future geothermal energy demand from the Kawerau Industrial Complex and geothermal power plants will be met by the remaining 44% consented geothermal volume.

Trends observed in the reservoir are as expected

Reservoir pressure is generally increasing

The reservoir pressure of a geothermal system changes at a rate influenced by the volume of geothermal fluid produced and the volume of fluid recharge from both natural recharge water and reinjected water. The Kawerau geothermal system has one of the smallest pressure changes related to the scale of geothermal development in New Zealand. The small pressure change has been maintained even after more than 60 years of continuous operation.

In 2020, the reservoir pressure was generally increasing in the Kawerau geothermal system. This means that the volume of geothermal fluid taken was effectively replenished by natural recharge and reinjected water.

Reservoir enthalpy (reservoir temperature) is decreasing at a stable rate

The enthalpy of the geothermal fluid produced describes the amount of thermal energy, in kilojoules, per kilogram of produced geothermal fluid. A higher enthalpy means a higher amount of thermal energy available for use. In Kawerau, the enthalpy trend is used to determine whether the geothermal reservoir is being produced at a sustainable rate.

In 2020, the enthalpy changes observed in most of the NTGA production wells are in line with the expected sustainable enthalpy changes. NTGA has commissioned new production well and reduced flow in others to redistribute production and improve the overall enthalpy of the system. NTGA continues to collaborate with the rest

of the geothermal system tappers to monitor and review strategies to ensure that the overall enthalpy trends remain sustainable.

Chemistry trends indicate increasing reinjection fluid returns in addition to natural recharge

The chemistry trends of the produced geothermal fluid provide an indication of underground reservoir processes. Understanding these processes helps in developing reservoir management strategies. Additionally, information from chemistry trends ensures the safe and reliable operations of our geothermal energy supply network, e.g., indicators of increasing risk for mineral deposition, corrosion, etc.

In 2020, chemistry trends indicate that several NTGA wells have increased returns from reinjection while others continue to produce fluids with a higher proportion of natural recharge. This is consistent with long-term trends showing the influence of both natural recharge and reinjection on NTGA production wells. The changes in chemistry trends continue to be monitored to ensure no adverse long-term effect on the enthalpy of the reservoir.

Trends observed in the environment are consistent with expected trends

Groundwater monitoring trends are mainly influenced by surface hydrology

The groundwater system overlying and interacting with the Kawerau geothermal system is monitored using a wide network of shallow bores. Monitoring activities detect changes to the groundwater system and are used to determine whether these changes are related to the geothermal field operations over time. To detect these changes, groundwater monitoring includes water level and groundwater temperature measurements as well as six-monthly or yearly groundwater chemistry analyses. The current groundwater monitoring program started in the 1990s.

In 2020, monitoring data indicated generally stable groundwater levels and slightly declining temperatures consistent with main influence from surface hydrology (rainfall events) with limited effects from geothermal operations and reinjection.

Surface thermal features continued to wane as expected

Surface thermal features in Kawerau include fumaroles, hot pools, heated ground and natural seeps. Changes to the thermal features located within the Parimahana and Te Taukahiwi o Tirotirowhetu Scenic Reserves are monitored through photographic surveys and ground temperature measurements.

In 2020, thermal features monitoring results indicate that the geothermal activity in the monitored thermal features continued to wane as expected. The activities of the surface thermal features have been noted to naturally decline since the 1900s.

Ground surface elevation changes in the industrial area are as expected

The ground surface elevation overlying geothermal systems might change as a response to geothermal operations, either as a downward trend (subsidence) or an upward trend (swelling) due to changes in the underlying reservoir pressure and temperature. Ground surface elevation is monitored in Kawerau due to the presence of industrial equipment that are sensitive to ground surface elevation changes. Ground level monitoring includes regular measurements of elevation benchmarks over an area of approximately 50 km^2. In addition, there is a higher level of monitoring around a relatively large “bowl” of slowly subsiding ground above the reservoir, within which five localised subsiding areas are of interest.

In 2020, a levelling survey was completed focussed on the 3 km^2 level-sensitive industrial area. It showed a steady year-on-year decline in subsidence rates in all identified long-term subsidence locations. In general, all the subsidence rates and tilt recorded are within expected ranges in the level-sensitive industrial area.

Greenhouse gas emissions continue to decline

Renewable energy from geothermal systems do release a relatively small amount of greenhouse gases (GHG) to the atmosphere, mainly as carbon dioxide (CO_2) and hydrogen sulphide (H_2S). The emissions from an average New

Zealand geothermal field is a small fraction of the emissions for an equivalent amount of energy from a fossil fuel-based source and usually declines as the system loses gas over time.

In 2020, the air emissions from NTGA's operations continued to decline. The low-level emissions benefit the Kawerau industries that continue to reduce their GHG emissions by increasing their use of geothermal energy supplied by NTGA.

Numerical Reservoir Model is updated

As agreed within the Kawerau System Management Plan, a geothermal reservoir simulation computer model is maintained by all geothermal tappers in Kawerau to help manage the geothermal system in a sustainable manner. This model helps simulate physical changes in the geothermal reservoir as a response to the geothermal operations carried out by multiple consent holders and operators. It uses the latest temperature, pressure and chemistry trends as well as geological and geophysical information collected over time to update the model and improve its predictive capability.

In 2020, the numerical model KRMv5 forecast was compared with the latest production, enthalpy and pressure data. The results indicate that the numerical model is sufficiently matching the actual data. Updated forecasts from the model indicate long-term sustainable geothermal development from the system at the current consented volumes.

Summary

NTGA's geothermal operations continue to provide an indigenous, renewable, reliable, and low-carbon energy supply to New Zealand process industries for more than 60 years. In the years since NTGA's purchase of the Crown steam field assets and steam supply business, it has continuously improved its capability to monitor, understand, and manage its operations in the Kawerau geothermal system.

In 2020, NTGA's geothermal operations complied with the requirements of its resource consents. The relevant reservoir and environmental monitoring trends are also within the expected trends and where possible, adaptive management is being carried out to ensure a sustainable geothermal operation. NTGA also continued to invest in the Kawerau steamfield such as production well drilling, additional surface facilities, scientific studies, and updates to the numerical reservoir model.

NTGA continues to engage and collaborate with all stakeholders to ensure that its activities in the Kawerau geothermal reservoir is carried out in a manner that is sustainable to the geothermal resource, the environment, and the community that it supports.