

Closed-Loop Geothermal Systems For Industrial Heat - Initial Case Study At Worsley Alumina

Conor Murray* (1), Graeme Beardsmore (1)

University of Melbourne* (1)

murraycj@student.unimelb.edu.au

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ABSTRACT

Australia has committed to net zero carbon emissions by 2050, largely focusing on mitigating emissions from electricity production. However, more than 20% of Australia's end use energy is consumed as heat for industrial processes, overwhelmingly from fossil fuels. Zero emission alternatives include electrification and green hydrogen production, but current assessments of the technoeconomic viability of those alternatives encourage the continued search for others. This work assesses the potential for emerging Closed-Loop Geothermal Systems (CLGS) to provide low to medium temperature ($< 250\text{ }^{\circ}\text{C}$) process heat for industry in Australia, presenting a case study for one of the country's five alumina refineries. These refineries are each among the largest individual consumers of industrial process heat in the country and so represent some of the most pressing challenges of the sustainable industrial heat transition. Initial estimates suggest that optimized CLGS designs could theoretically deliver the $\sim 600\text{ MWt}$ required by the case study refinery in Western Australia. Example designs are presented, along with a methodology for further reducing uncertainty in the outputs and determining the feasibility of CLGS as a heat source for heavy industry.

1 INTRODUCTION

1.1 Alumina

Alumina, or aluminum oxide (Al_2O_3) is the precursor chemical to Aluminum metal. It is produced around the world, however the largest exporter and second largest producing nation is Australia, where more than ten million tons are produced annually (17.4 MT in 2024) (Australian Aluminium Council, 2025). Production is primarily via the Bayer Process (Figure 1), which is itself comprised of two main heat-consuming steps: digestion of raw bauxite at $150 - 200^{\circ}\text{C}$ and calcination of slurry into aluminum oxide at $1000 - 1100^{\circ}\text{C}$ (Tabereaux and Peterson, 2013). Of these, digestion consumes between 50 and 70 percent of the total heat requirement (approximately 10.5 GJt per ton of alumina produced). At present in Australia, this heat is provided entirely by burning natural gas and coal (Deloitte, 2022).

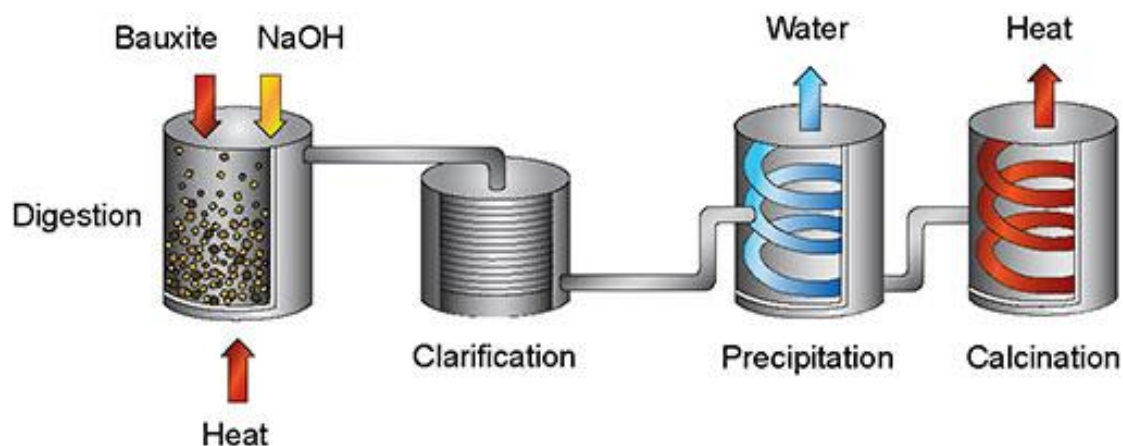


Figure 1: The Bayer Process for alumina production. Heat is primarily consumed in the digestion and calcination steps

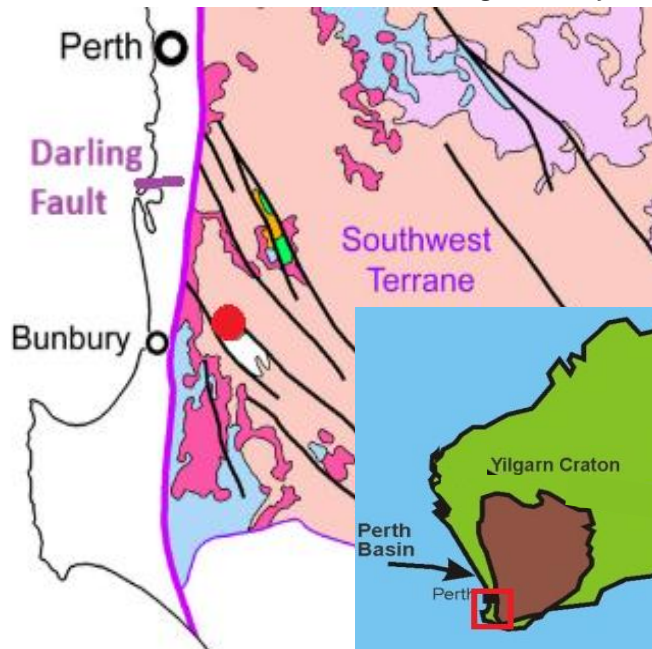
1.2 Closed-Loop Geothermal Systems

Closed-loop geothermal systems (CLGS) are an emerging geothermal energy technology, comprised of networks of subsurface wells through which a working fluid is passed (Esmailpour et al, 2022). The working fluid extracts heat from surrounding rock via thermal conduction before being returned to the surface where heat is

used. The cooled fluid is recirculated, hence the term 'closed-loop'. Like other geothermal energy technologies, the specific geology of the target area influences the system design and predicted outputs. In particular, the outputs of conduction-based CLGS are highly dependent on the thermal conductivity and initial temperature of the host rock. They are far less dependent than other geothermal technologies on natural or induced permeability and porosity (Robles et al, 2023).

1.3 Objective of this Study

This work focuses on a specific CLGS design, the Eavor-Loop™ by Eavor Technologies ('Eavor'). This design includes long horizontal or sub-horizontal laterals that connect separate injection and production bores. The lateral sections are uncased, instead being sealed by Eavor's proprietary chemical Rock-Pipe™ sealant (Toews et al, 2020). Systems are typically designed with ten or more laterals and target depths of several kilometers below the surface.



This work provides a preliminary assessment of the potential for CLGS to provide the digestion heat of a single alumina refinery in Western Australia. Worsley Alumina Refinery is operated by South32, a minerals company based in Perth, Western Australia. The site is located on the Yilgarn Craton approximately 200 km south of Perth, and 10 km east of the Darling Fault (Figure 2). The refinery produces approximately 3.7 million tons of alumina annually, using live steam at approximately 150°C for the digestion of bauxite and requiring around 600 MWt thermal power for the heating of the steam (Calculated based on Deloitte, 2022, Taberaux and Peterson, 2013, and South32, 2025). Natural gas and coal are currently burnt to provide the heat.

Figure 2: Study Setting, Western Australia. Worsley is highlighted in with a red circle (Modified from PorterGeo database)

2 METHODOLOGY

Evaluating the feasibility of applying CLGS technology to industrial alumina production is a multidisciplinary process. This process was divided into the following phases:

1. Development of software to model and predict the thermal outputs of a CLGS
2. Analysis of the geological setting and estimation of relevant parameters
3. Testing of CLGS designs for the generation of the required temperature and power outputs
4. Development of an enviro - economic model for CLGS construction and operation over a system lifetime
5. Comparison of CLGS thermal and economic outputs to natural gas base - case

This paper reports on progress to date, including software development and a preliminary appraisal of the potential for Eavor-Loop™ CLGS designs to provide for the thermal requirements of Worsley Alumina. The remaining stages are yet to be completed (in particular, the enviro-economic modelling) or remain subject to significant assumptions and uncertainties.

2.1 Code Description

To accurately predict the thermal outputs of a CLGS, a physics - based program was developed in Python 3.1. The program operated by coupling one dimensional fluid energy equations within the wellbore to the heat equation within the formation via a heat-flux equality condition at the wellbore boundary. These coupled equations were then solved via a finite - element approach over the system lifetime.

The fluid energy equation used in the wellbore was (Acheson, 1990):

$$\frac{\partial}{\partial z} [\rho v (v^2 + g z \sin \theta + h)] = U (T_B - T_f) \quad (1)$$

In this equation, z represents axial distance along the wellbore, ρ is the density of the fluid, v is the velocity of the fluid, g is the acceleration due to gravity, θ is the angle of the wellbores with respect to the horizontal, h is the specific enthalpy of the fluid, U is the heat transfer coefficient, T_B is the temperature of the borehole wall, and T_f is the temperature of the fluid. All units are SI standard unless otherwise stated. The heat transfer coefficient was calculated using either the Gnielinski (Gnielinski, 1976) or Bhatti-Shah (Bhatti and Shah, 1984) Nusselt correlations, depending on the Reynolds number and relative pipe roughness.

The fluid energy and heat equations were discretized into cylinders of finite length (for the fluid) and into annuli of finite length and radial thicknesses (in the case of the heat equation) and solved iteratively for each length segment of the pipe via the tridiagonal matrix algorithm. Before the new temperatures were calculated at each time step, the pressure change was calculated via:

$$\Delta P = - \frac{\rho v^2 f \Delta z}{2D} + \rho g \Delta z \sin(\theta) - \rho g v \Delta z \quad (2)$$

P is fluid pressure, f is the Darcy friction factor, D is the pipe diameter, and other variables are as for Equation (1). The Darcy friction factor was calculated via the Chen equation (Chen, 1979).

Fluid thermal properties were calculated via the IAPWS formulations for each length step at each timestep, except for the specific enthalpy. This was calculated via a linear correlation of temperature and pressure based on the IAPWS formulation to extract the temperature for calculation (IAPWS, 2007, 2008, 2011).

The change in fluid velocity was calculated using a steady state mass continuity equation.

2.2 Validation

The program described above was validated against results published by Beckers and Johnston (2022), in which a Slender Body Theory solver (Beckers et al, 2015) was used to model an Eavor-Loop™ with twelve 6.5 km long laterals inclined at 70° from horizontal. The total depth of the system was approximately 7.5 km, the inlet temperature, pressure and flow rate were 60°C, 10 MPa and 80 kg/s respectively. Beckers and Johnston ran simulations for two different geothermal gradients and produced plots of pressure and outlet temperature. The program described above closely reproduced Beckers and Johnston's results, with the predicted temperature outputs of each shown below in Figure 3. The code described here predicted a lower initial temperature and more rapid initial temperature decline than Beckers and Johnston's prediction, but the long-term output is similar.

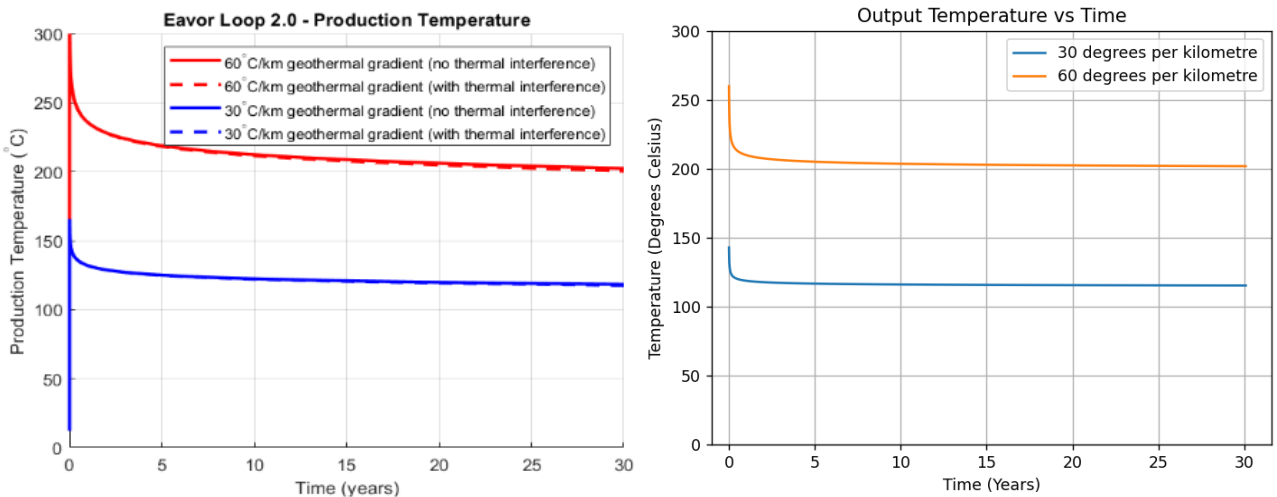


Figure 3: Predicted Eavor-Loop™ 2.0 production temperature from Beckers and Johnston (2022) (Left) and using the code described above (Right).

2.3 Geological Setting and Parameters

The location of Worsley Alumina Refinery in the Southwest Terrane of the Yilgarn Craton is shown in Figure 2. The Southwest Terrane is predominantly granitic in its composition, however along the Darling fault are belts of greenstone and metasedimentary rocks, shown as bright pink and light blue in Figure 2 (Department of Mines, Petroleum and Exploration, 2021). It is assumed that the Worsley refinery is not underlain by either of these kinds of belts, rather by granitic gneiss and granitic rocks.

Accurate estimation of the temperature and thermal conductivity of the rocks at the modelled depth of the laterals is critical to accurately predicting the outputs of a Closed-Loop Geothermal System. However, there are no deep boreholes in the vicinity of Worsley Alumina Refinery on the eastern side of the Darling Fault. Therefore, significant uncertainties in the values of the thermal conductivity and temperature at several kilometers below the surface are to be expected. Due to the sensitivity of the thermal outputs of a CLGS to these parameters, the uncertainty in temperature and power outputs of the geothermal system will also be significant. Further geophysical investigation will be performed to decrease these uncertainties during later stages of this investigation, however a preliminary process for estimating the temperature and thermal conductivity at reservoir depth is described below.

As stated above, it is assumed that the Worsley refinery is underlain by granitic gneisses, particularly tonalite-trondhjemite-granodiorite (TTG) gneisses, and that these gneisses are continuous down to the target depth. An estimate of the thermal conductivity for these rocks was determined based on measurements made by Podugu et al, 2017, which were then corrected for an estimated in-situ temperature distribution using the following equation (Sekiguchi, 1984):

$$k = \frac{T_0 T_m (k_0 - k_m)}{(T_m - T_0)} \left(\frac{1}{T} - \frac{1}{T_m} \right) + k_m \quad (3)$$

In this equation, T refers to the temperature (K) to which the conductivity (k; W/mK) is to be corrected, the subscript '0' refers to the laboratory conductivity measurement conditions, while 'm' refers to calibration constants ($T_m = 1473$ K, $k_m = 1.05$ W/mK). The temperature at a given depth was estimated according to the following (Beardsmore and Cull, 2001):

$$\int \frac{Q_0 - \int A(z) dz}{k(z)} dz + T_0 = T_D \quad (4)$$

Where Q_0 is the surface heat flow (estimated from measurements in the Global Heat Flow Database and Hot Dry Rocks, 2008), $A(z)$ is the heat generated within the TTG gneiss (estimated from Korhonen et al, 2024), and D refers to the depth of the lateral sections of the CLGS. As the thermal conductivity of a substance depends on its temperature, this calculation was repeated iteratively to improve the concordance between the thermal conductivities and their corresponding temperatures as they varied with depth. The assumed values and uncertainties for the relevant parameters are shown in Table 1.

Equation (4) was subjected to a Monte Carlo analysis to calculate a distribution of both the temperature and thermal conductivity with depth. The determined conductivities and temperatures are displayed in Figure 4.

Table 1: Values of parameters used to calculate the temperature distribution with depth at the site

Parameter	Mean	Standard Deviation
Heat Generation ($\mu\text{W}/\text{m}^3$)	1.88	1
Laboratory Thermal Conductivity (W/m/K)	2.97	0.4
Surface Heat Flow (mW/m^2)	50	5

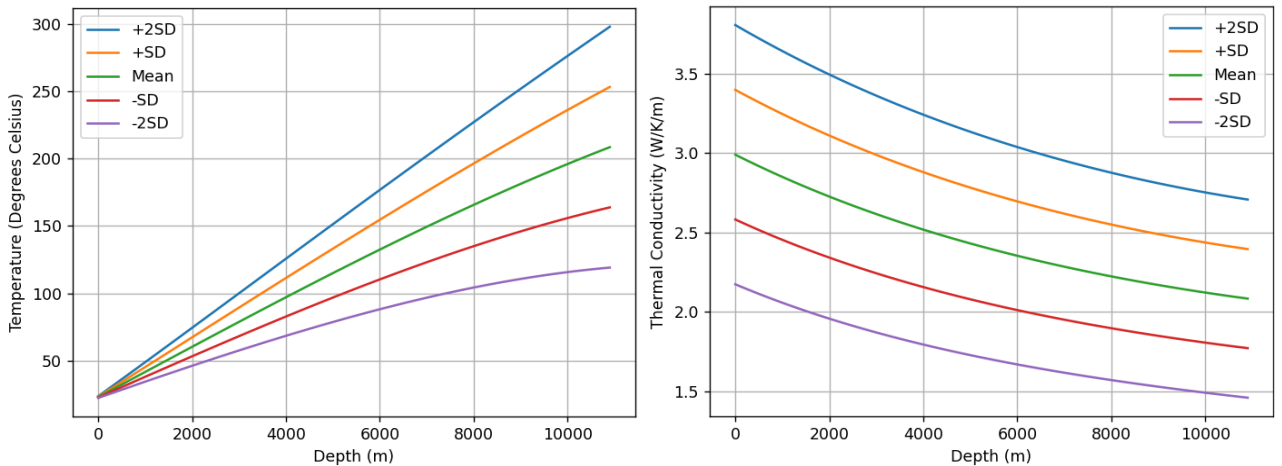


Figure 4: Interpreted Temperature and Thermal Conductivity distributions below the Worsley Alumina Refinery. Mean values are shown, as well as two standard deviations in either direction.

In future works, the compressive strength and stress field of the subsurface, and therefore its ability to support horizontal open-hole wells, will also be quantified. Here, however, it is assumed that this will be possible.

2.4 Closed-Loop Geothermal System Designs

The parameters around which CLGS designs were generated were as follows: the maximum depth of the system, the length of the lateral sections, the inlet flow rate, the angle of the lateral sections and the inlet fluid temperature. The exact length of the vertical sections will be moderated according to the angle and length of the laterals in order to achieve the desired maximum depth.

The vertical sections are considered cased with cement and steel casing, while the lateral sections are uncased, instead being sealed with Eavor's Rock-Pipe™. It is here assumed that the integrity of the Rock-Pipe™ seal will be maintained over a system lifetime of 30 years. The bounds of each of the varied parameters are shown in Table 3. All other parameters (for example, the fluid inlet pressure and the vertical wellbore radius) were held constant. The inlet flowrate is listed as both an initial and a final flowrate; the flowrate increases logarithmically from one to the other to maintain a near-constant power output over the 30-year lifetime of the system. Further, it is assumed that an outlet temperature of 150 °C is sufficient for the digestion of the bauxite at Worsley. Implicitly, this assumes that the outlet fluid can be used directly as live steam for the process. Future work will include site and process analysis of Worsley to determine if this is possible.

Table 3. The parameters varied for the CLGS simulations. Note that for the inlet flow rate, the values are listed as (initial/final). Also listed are the constant parameters.

Parameter	Minimum	Maximum	Increment
Total Depth (m)	5000	10000	1000
Lateral Length (m)	2000	7000	1000
Initial/Final Inlet Flow Rate (kg/s)	5/20	20/100	1.67/20
Lateral Angle (degrees)	0	90	15
Inlet Temperature (°C)	60	140	10
Horizontal Section Radius (m)	0.1	-	-
Vertical Section Radius (m)	0.108	-	-
Inlet Pressure (MPa)	10	-	-
Number of Laterals	12	-	-

All configurations were initially tested over a simulation of one year. The simulated system configuration was considered to have failed if the temperature output dropped below 150°C. Configurations that passed the test after one year of simulation were then simulated for 30 years.

The minimum depth, flow rate, and lateral lengths are based on early testing of the CLGS software. Values less than those in Table 3 for these parameters are considered unlikely to reach the required temperature or power outputs. The maxima are selected to reflect near-future technical and economic feasibility, and in the case of the flow rate, maintaining acceptable pressure drops and temperatures throughout the system. Set parameters are drawn from existing Eavor-Loop™ designs (Holmes et al, 2020).

2.5 Economic Proxies

A rigorous economic model has not yet been developed, however CLGS designs will be compared by the lengths of lateral and vertical drilling required as a proxy for cost. This is considered reasonable, if simplistic, as the cost of drilling comprises approximately 80% of the lifetime cost of a CLGS (Barry-Hallee, 2022).

2.6 Simulations

Simulations were run in two parts in order to save computation time. Every configuration was tested for each of the five thermal regimes shown in Figure 3. The configurations that failed to achieve or maintain an output

temperature of over 150°C were discarded. Those that passed the initial phase were then run again, for a period of 30 years. Initially, 6300 configurations were tested for each set of thermal conditions.

For the second test, the configurations were simulated for a period of 30 years operating time. Configurations were required to maintain both a temperature of over 150°C and an output pressure higher than the inlet pressure (to minimize parasitic pumping power) over this system lifetime.

3 RESULTS AND DISCUSSION

The results of the simulations are shown in Table 2. Notably, in configurations with both low temperature and low conductivity, all designs failed to reach or maintain 150 °C after a year of operation. The pass rate at one year for mean conditions was low (around 3%) however for higher temperature and thermal conductivities, the pass rate increased by approximately 20% per standard deviation above the mean. Unsurprisingly, deeper configurations with higher injection temperatures were more likely to pass, as were configurations with longer laterals. Also strongly represented in the passing sample were configurations with less angular deviation in the laterals. This is likely because the lower angle increases the average depth, and therefore temperature of the rock encasing the laterals. Interestingly, moderate flowrates were more successful in passing the temperature threshold than either low or high flowrates. This may be intuitive for the high flow rates, however the reason for the low temperature from lower flow systems is less obvious; slow flowing fluid should intuitively absorb more heat from the subsurface. However, a low flow rate also enables significant thermal losses to the surrounding rocks in the vertical section of the wells. This is compounded with higher inlet temperatures.

Table 2: Overall Results of both sets of simulations.

Thermal Regime	# Configurations (First Pass)	Passes	Passes (Second Simulation)	Total Pass Percentage
- 2 Standard Deviations	6300	0	-	0
-1 Standard Deviations	6300	0	-	0
Mean	6300	196	128	2.03
+1 Standard Deviation	6300	1479	1100	17.46
+2 Standard Deviations	6300	2838	2278	36.16

The results of the second set of simulations are also in Table (NUMBER). 64% of the configurations that passed the one-year test in the mean thermal regime passed the 30-year test. This is compared to 74% and 80% for thermal conditions one and two standard deviations above the mean respectively. Most of the difference is due to failing to reach the pressure target. That is, 93% of configurations that maintained 150 °C after one year continued to maintain outputs over 150 °C after thirty years, and 70% of second-stage failures were due to insufficient outlet pressure.

The addition of the pressure condition decreased the representation of high inlet temperatures within the final sample. This is because the high inlet temperature results in a lower density difference between the inlet and outlet of the system, and thus the pressure losses through friction outweigh any potential gains through density decrease. This was particularly true for high flow rate cases.

Notably, no configuration with a true vertical depth of less than 9 kilometers was able to meet the temperature and pressure criteria in the case of mean expected thermal conditions. In the most optimistic case, the conditions were able to be met with 6 km true vertical depth systems with no lateral deviations from horizontal, leading to still relatively high measured depths (minimum of 7500 m).

For each configuration in the second pass, the output power after 30 years was calculated by subtracting the enthalpy of the fluid at the inlet from that at the outlet and multiplying by the inlet flow rate. For the three thermal regimes with successful configurations, the maximum power produced per loop, and the corresponding parameters are shown in Table 3. The median successful configuration power output of the three thermal regimes was 3.89, 7.55 and 11.10 MWt, respectively.

Table 3: Maximum Power produced in each thermal regime, and the relevant configuration parameters.

Parameter	Mean Conditions	+1 Standard Deviation	+2 Standard Deviations
Power (MW)	15.41	31.46	45.84
Outlet Temperature (°C)	150.85	153.09	168.34
TVD (m)	10000	10000	10000
Lateral Length (m)	7000	7000	7000
Lateral Angle (Degrees)	0	0	0
Final Inlet Flow (kg/s)	40	80	100
Inlet Temperature (°C)	60	60	60

Of note in Table 3 is the concordance between the values of these parameters across thermal regimes. Unsurprisingly, drilling the deepest possible wells with the longest possible laterals at the shallowest possible angle results in the highest power output across the board. However, the results also indicate that a lower inlet temperature is favourable. The ideal flow rate is the highest possible that allows for both the temperature and pressure conditions to be met with the lowest possible inlet temperature. This suggests that over the range of inlet conditions tested, inlet temperature is a stronger predictor of outlet power. It should be noted that the highest producing system in the +2 standard deviation case produced fluid of over 165°C and with pressures over two MPa higher than inlet conditions and so could potentially support higher flow rates and thus produce more power.

For industrial application of CLGS, the cost of power is equally as important to quantify as the power output itself. As stated above, drilling accounts for most of the total capital expenditure of constructing a CLGS, which in turn is the bulk of the total lifetime cost. As such, the total drilled length is a reasonable proxy for levelized costs of heat in the absence of a rigorous economic model.

Table 4 shows the results for configurations optimized for maximum power output per meter of drilling. The most cost-effective configurations for the mean and +1 standard deviation cases are the same as those with the highest power output (Table 3). In the +2 standard deviation case, however, deviating the laterals by 15° and decreasing the lateral length by 1000 m resulted in a higher power output per meter of drilling. Compared to the configuration in Table 3, the power output is almost 6 MWt lower, but the system requires around 13.5 km less drilling. However as stated above, the system presented in Table 3 likely does not have an optimized inlet flow rate and so may still be the most cost-effective option. The median power per drilled length for the three configurations are 44.21, 101.52 and 162.75 Wt/m.

Table 4: Maximum Power per drilled length in each thermal regime, and the relevant configuration parameters. Asterisks denote configurations that also have the highest total power output

Parameter	Mean Conditions*	+1 Standard Deviation*	+2 Standard Deviations
Power per metre (W/m)	148.22	302.52	472.28
Outlet Temperature (°C)	150.85	153.09	154.34
True Vertical Depth (m)	10000	10000	10000
Lateral Length (m)	7000	7000	6000
Lateral Angle (Degrees)	0	0	15
Final Inlet Flow (kg/s)	40	80	100
Inlet Temperature (°C)	60	60	60

In the case of Worsley, and other large industrial facilities, more than a single Eavor-Loop™ will be required to meet the total thermal power demand. Considering a CLGS as a discrete unit, the most cost-effective single system may not be the most cost effective for an entire facility. For example, a 60 MWt system may produce the highest power per drilled meter, but if the facility requires 70 MWt, two less individually cost-effective CLGS with

35 MWt output each may be optimal. In Table 5 are the parameters and the power outputs per meter of the optimal multi-CLGS to generate 600 MWt under each set of thermal conditions. Also shown are the number of each individual configuration required to cover the total power output. No sharing of vertical wells was assumed, or 'stacking' of CLGS systems; each loop is assumed to have newly drilled vertical wells laterally separated from other loops.

Table 5: Maximum Power per drilled length for a 600MW system in each thermal regime, and the relevant configuration parameters. Asterisks denote configurations that also have the highest total power output, tilde denotes systems with the highest individual power per drilled length

Parameter	Mean Conditions*~	+1 Standard Deviation*~	+2 Standard Deviations
Power per meter (W/m)	147.93	288.46	451.62
Outlet Temperature (°C)	150.85	153.09	162.33
Number Required	39	20	14
TVD (m)	10000	10000	10000
Lateral Length (m)	7000	7000	7000
Lateral Angle (Degrees)	0	0	15
Final Inlet Flow (kg/s)	40	80	100
Inlet Temperature (°C)	60	60	60

Again, the most cost-effective systems for the mean and +1 standard deviation cases are the maximized power output cases. In the mean thermal regime, the maximized case is far and away the most cost effective; any configuration that requires less drilling per loop would need at least 10 more loops to deliver 600 MWt and would generate at least 30 fewer watts per meter. The other cases have a greater diversity of potentially viable system configurations, but few involve shallower depths. The configurations with 'next best' powers per unit length tended to be 10000 meters deep, with shorter laterals, or with equally long, 15-degree dipping laterals. As a result, either a lower throughput of fluid or a lower inlet temperature was required to maintain 150°C output, or a lower temperature was achieved, resulting in a lower power per unit length.

The median number of CLGS loops required to provide 600 MWt across all successful configurations was 155, 80, and 55 for the three sets of thermal conditions, respectively.

In general, the true vertical depth and lateral length are the strongest predictors of output temperature. The interacting effects of different parameters, however, make assigning priority to other parameters difficult. For example, high inlet temperature is a strong predictor of high output temperature only if the flow rate is also high. If the flow rate is low, the inlet temperature is almost irrelevant. The threshold flow rate at which this change occurs is dependent on the system geometry. The angle of the laterals from horizontal is an important factor in so far as it determines the average depth of the laterals, and therefore the average rock temperature at which most of the heat transfer occurs. With lower flow rates in particular, higher lateral angles should be avoided. This combination may result in fluid reaching temperatures higher than rock temperature in the up-flow sections of the laterals and thus cooling to the initial temperature at the base of the vertical wells. Generally, higher angles result in lower temperatures and powers, but if the length of the vertical sections rather than the total depth is held fixed, these relationships are inverted.

If optimizing to minimize the levelized cost of heat (or to maximize thermal power output per length of drilling), there exists a tension between maximizing output power and minimizing drilling length. In general, the results seem to suggest that maximizing the output power should be prioritized over minimizing the drilling length. For both the mean and +1 standard deviation case, the configuration that generated the most power was also the most cost-effective. However, this was not the case for the +2 standard deviation regime. This may be due to the greater diversity in the configurations that passed the output test relative to other thermal regimes. However, it is also possible that the optimal system for the +2 standard deviation thermal regime lies outside the bounds of the inlet temperature and flow rate parameters tested here—the optimal systems in the mean and +1 standard deviation regimes were those with the highest flow rate and lowest inlet temperature that met the passing conditions. For the +2 standard deviation case, the highest power output configurations used both the highest

tested flow rate and the lowest tested inlet temperature, while maintaining a temperature and pressure of 18°C and 2.3 MPa, respectively above the thresholds. A higher flow rate or lower inlet temperature may have aligned the optimal total power and power-per-meter configurations.

4 CONCLUSION

The temperature, power outputs, and produced power per unit system length for a range of CLGS configurations and subsurface conditions have been tested for application to the Worsley Alumina Refinery in Western Australia.

The results highlight the importance of tightly constraining the vertical distributions of thermal conductivity and subsurface temperature for CLGS. Over the five thermal regimes outlined and tested in this work, the range of theoretically viable systems vary wildly, from 6000-meter-deep systems producing fluid at 160°C after 30 years to others with measured depths of 17 km being totally unviable after one year. As such, subsequent work will have a heavy emphasis on new geophysical surveys (magnetotellurics) and rock property measurements to better constrain the subsurface conditions at Worsley.

Next steps will also include tightened parameter bounds and intervals in parameter space, particularly where inlet flow and temperature are concerned. For each thermal regime and system geometry, there exists a 'sweet spot' of high flow rate and low inlet temperature that maximizes the power output from a CLGS while meeting the output temperature requirement. It is likely that this sweet spot lies between points currently tested for each configuration in the flow rate-temperature parameter space.

Engagement is also planned with thermal process engineers and drilling contractors to more accurately determine a reasonable range of depth values and output temperature thresholds for CLGS at the site. In addition, economic modelling over a system lifetime will be performed for comparison with the present cost of powering Worsley's Bayer Process.

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