ASX Announcement

VRXSILICA

3 November 2023

Farm-In and JV Agreement for Dandaragan Geothermal Exploration Permit

Highlights:

- **Attractive Farm-In and JV structure provides VRX with exposure to development of GEP 44**
- **Provides VRX with a potential alternative energy solution for its silica sand projects and downstream processing, including glass manufacturing**
- **Steam Resources has the requisite technical team and expertise to explore the potential of GEP 44 and develop the project**
- **VRX retains underlying mineral rights in the project area both in hard rock and brine solution**

VRX Silica Limited (**VRX** or **Company**) (ASX: VRX) is pleased to announce it has entered into a Farm-In and Joint Venture Agreement (**Agreement**) with Hydro X Gen Pty Ltd (**HXG**) for the Company's granted Geothermal Exploration Permit (**GEP**) at Dandaragan, 145km north of Perth, Western Australia.

HXG is planning to conduct an initial public offering and list on the Australian Securities Exchange as Steam Resources Limited (www.steamresources.com.au) in 2024 (**Steam**).

Geothermal technology has the potential to produce long term dispatchable renewable energy for the Mid-West region, including VRX's Arrowsmith silica sand projects.

The grant of GEP 44 was announced to ASX on 28 July 2023. It consists of 8 contiguous blocks and the area includes the Walyering gas field currently under development by EP447 Joint Venture between Strike Energy 55% and Talon Energy 45%. The project provides an opportunity to work with these gas companies and use extensive historical and current data to explore potential geothermal power options.

Under the terms of the Agreement, Steam can earn up to a 90% interest in GEP 44. Steam is required to complete an agreed exploration program and drilling campaign by 31 July 2026 to earn an initial 40% interest in the project and an additional 30% interest by completing a feasibility study assessing the economic viability of the production of energy from geothermal sources within the project area by that date.

ASX: VRX

Capital Structure

Shares on Issue:
583 million

Unlisted Options:
59 million

Corporate Directory

Paul Boyatzis
Non-Executive Chairman

Bruce Maluish
Managing Director

Peter Pawlowitsch
Non-Executive Director

David Welch
Non-Executive Director

Ian Hobson
Company Secretary

Silica Sand Projects

Arrowsmith *Silica Sand Projects, 270km north of Perth, WA.*

Muchea *Silica Sand Project, 50km north of Perth, WA.*

Boyatup *Silica Sand Project, 100km east of Esperance, WA.*

Geothermal Energy

Dandaragan *Geothermal Energy Permit, 145km north of Perth, WA*

The Company is actively assessing other silica sand projects in Australia.

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Steam may earn an additional 20% interest upon the production of energy from geothermal sources within the project area by 31 July 2029. VRX is not required to contribute funding for development of the project.

Steam has the requisite experience and expertise to explore and develop the project.

Steam Resources Managing Director Josh Puckridge said:

"Permit 44 represents a unique development opportunity for geothermal energy production in Western Australia that complements our other project areas in the Northern Territory and South Australia.

"Recent developments in supercritical CO_2 *geothermal plant design greatly increases the potential for significant baseline production of green geothermal energy in Western Australia.*

"Leveraging Steam's work in the geothermal industry with Permit 44 is of great value to our shareholders and the shareholders of VRX."

VRX Managing Director Bruce Maluish said:

"This geothermal exploration initiative was undertaken by VRX Silica to support our silica sand projects and long-term ambitions for the production of glass in Western Australia. Geothermal energy is a reliable, long-term renewable energy source and we identified this opportunity for a new renewable energy industry in the Mid West.

"We are impressed by the credentials of Steam's management team and look forward to working with them to realise the full potential of the Dandaragan geothermal project.

"In the meantime, VRX Silica continues work on the development of our silica sand projects at Arrowsmith, Muchea and Boyatup as we strive to become a leading supplier globally of high-quality silica sand products."

GEP 44

In December 2021 VRX lodged an Acreage Release nomination with the Department of Mines, Industry Regulation and Safety (**DMIRS**) for specified areas in the Mid-West to be included in a geothermal acreage release. In January 2022 DMIRS released 21 areas in Western Australia for applications for GEPs with a closing date for applications of 21 April 2022. GEPs are administered by DMIRS under the Petroleum and Geothermal Energy Resources Act 1967 with areas released as a Discrete Area Release. Successful applications are determined through a competitive bidding system. VRX has made application for three GEPs and has been notified the other two permits are progressing through a section 69A *Petroleum and Geothermal Energy Resources Act* 1967 consultation phase. There is no timeline for this process. GEP 44 has been denoted as the Dandaragan Geothermal Project, Figure 1 and Table 1 show its location and details.

GEP	Holders	Grant Date	Term	5' Blocks
44	VRX Silica Ltd	27 July 2023	6 years	8

Table 1: VRX Geothermal Exploration Permits

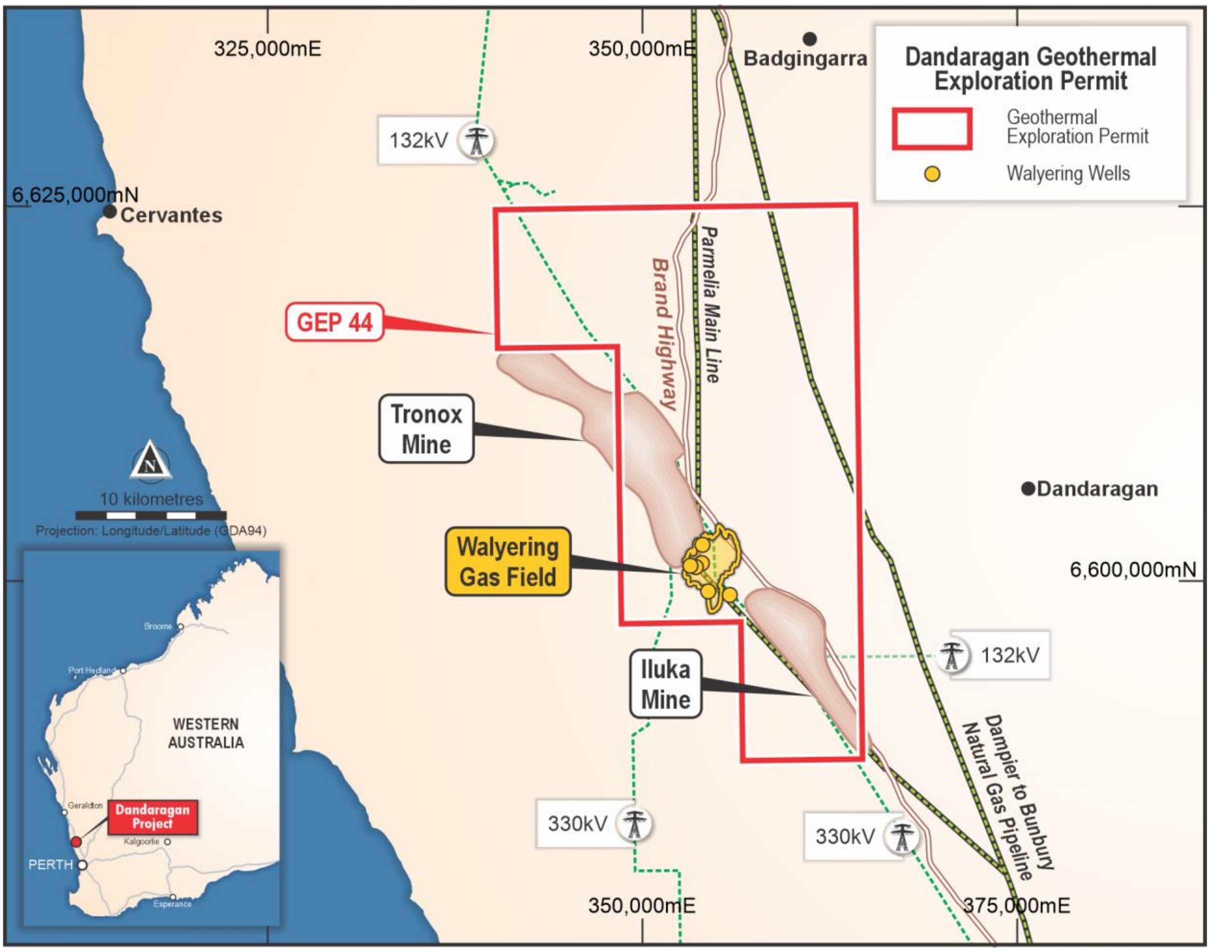


Figure 1: Dandaragan Geothermal Exploration Permit Location

Geothermal Exploration Concept

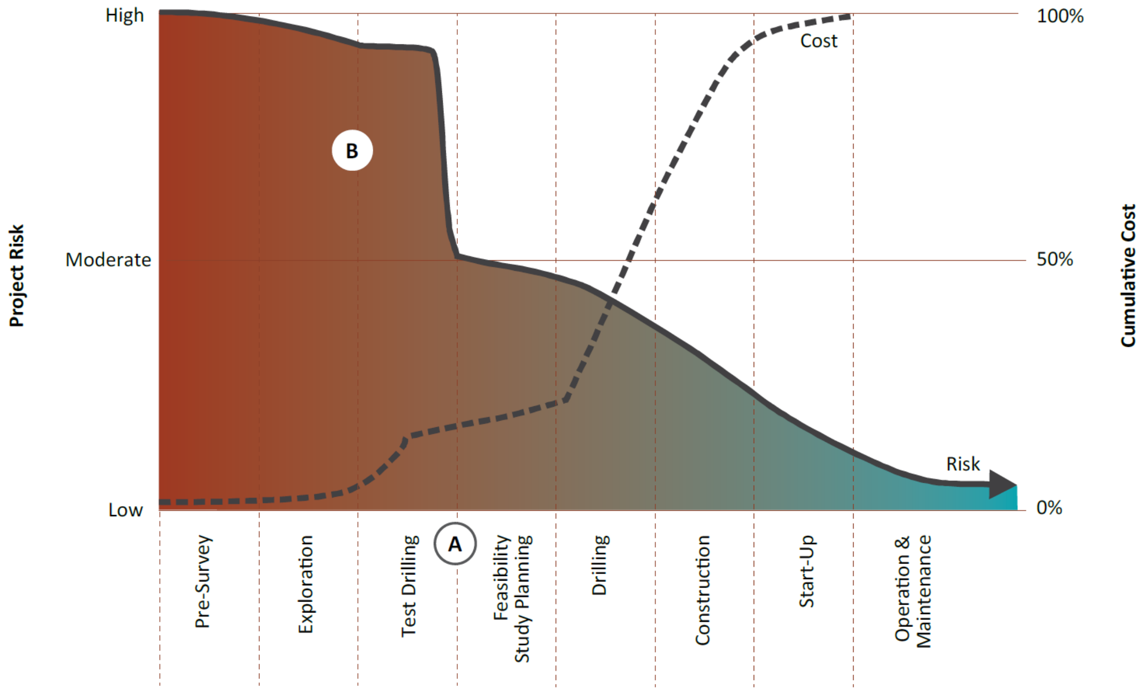
A geothermal energy source is an accumulation of extractable heat deep in the Earth's subsurface. Heat (thermal energy) is directly proportional to temperature, and water (either liquid or vapor) is almost always the medium by which geothermal energy is brought to the Earth's surface via boreholes. For geothermal energy to be extractable, water must be able to flow through hot rock from an injection well to a production well.

For 'hot sedimentary aquifers' (the principal target in the North Perth Basin), it is important to target the maximum temperature, volume and transmissivity of the reservoir rocks. The goal of a geothermal exploration program is to progressively build confidence in predictions of temperature, reservoir properties, and geometry (depth, extent, thickness) of target geothermal reservoirs, culminating in the drilling of one or two appraisal wells. Semi-independent work streams can investigate the three elements (temperature, reservoir properties, geometry) in parallel, with results integrated into one or more 'conceptual models' of the geothermal system(s).

GEP 44 is in an area of petroleum gas production development, providing an opportunity to work with the current gas companies to use extensive historical and current data to explore for potential geothermal power options. Not all petroleum well data will be ideal for the exploration of geothermal energy, however it will provide a good basis and guide on where to create new information.

Figure 2 shows a typical project cost and risk profile during the development of a geothermal energy project. The graph shows that the risks are high in the early stages of exploration but reduce significantly once the reservoir has been drilled and verified. The costs associated with the activities are inversely proportional to the risk and only increase significantly after the risk is reduced.

There is significant risk up to the point where test drilling has confirmed the resource size and that it can be extracted economically (labelled A).



Adapted from Gehringer & Loksha (2012).

Figure 2: Project costs and risk profile through the development of a geothermal resources[1]

Geothermal Exploration Program

The exploration program is expected to begin with the compilation and quality assurance of all relevant historical exploration and geoscientific data/information about the geothermal potential of the bid area. This will establish the baseline from which to carry out targeted exploration activities.

Existing data sets will be reprocessed and/or reinterpreted to focus on characterising 3D geometry and geothermal reservoir potential, with the initial assessment identifying key information gaps that can be addressed by the collection of new data. New data collection will take the form of geophysical surveys; surface, airborne, and/or borehole. All data will be compiled into a 3D geological model forming the basis for predictions of temperature and reservoir properties, which will be continually updated as new information becomes available.

An appraisal well will ultimately be drilled to test the most attractive target reservoir once near-surface exploration activities are no longer cost effective for reducing uncertainty in predictions of temperature, reservoir properties, and geometry. If results are promising, a production and injection doublet will be drilled to create a circulation loop to demonstrate heat recovery and power conversion.

[1] ARENA 2014 Report – “Looking Forward: Barriers, Risks and Rewards of the Australian Geothermal Sector 2020 and 2030”

What is Geothermal Energy?

Geothermal energy is a clean, virtually emissions-free, renewable energy resource produced from underground reservoirs of water naturally heated by Earth's internal heat. Steam and brine produced from these underground reservoirs can be used to turn turbines to produce electricity either directly or using "organic rankine cycle binary plants", see Figure 3.

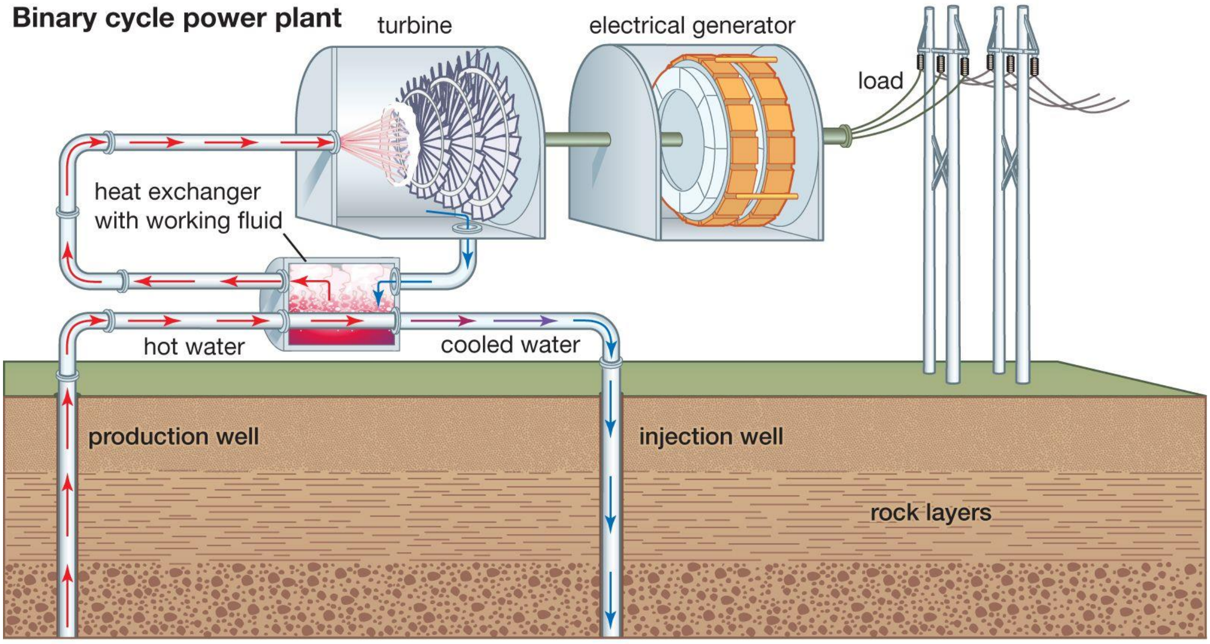


Figure 3: Typical Binary cycle geothermal power plant

Why Geothermal?

The Australian Renewable Energy Agency (**ARENA**) produced a report[2] in 2014 to assess the barriers and opportunities for geothermal energy development in Australia. The report found that Australia does have a large geothermal potential to generate direct heat or electricity. It identified the strength of geothermal power generation to be a source of dispatchable power with a low environmental footprint. The report also states "*Geothermal-sourced electricity is among the cheapest in the United States … and plays an important role in the dispatch of power to meet renewable portfolio standards. This is primarily because of its ability to provide base-load renewable generation to backstop variable renewable sources, such as wind and solar.*"

A subsequent ARENA report in 2018[3] looked at comparing the cost of dispatchable renewable electricity options. This report identified, on a levelised basis, geothermal electricity generation as a cost-effective solution for base load, 24 hour dispatchable power which easily competes with, or beats, all other renewable alternatives which are non-dispatchable, such as wind and solar PV.

The prospect to produce a renewable energy source in the Mid West is an opportunity to add to the growing reputation that the Mid West will become the central hub for renewable energy and downstream use in Western Australia.

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[2] ARENA 2014 Report – "Looking Forward: Barriers, Risks and Rewards of the Australian Geothermal Sector 2020 and 2030"
[3] ARENA 2018 Report – "Comparison of Dispatchable Renewable Electricity Options – Technologies for an orderly transition"

There is a long term prospect to use renewable energy to produce hydrogen to use in “green” glass manufacturing. Technically it has been well established that hydrogen can be used as the energy source for heating required to produce glass.

Plant type	Capacity factor (%)	Levelised capital cost	Fixed O&M	Variable O&M (including fuel)	Transmission investment	Total system levelised cost
Dispatchable technologies						
Conventional coal	85	65.7	4.1	29.2	1.2	100.1
Advanced coal	85	84.4	6.8	30.7	1.2	123.0
Advanced coal with CCS	85	88.4	8.8	37.2	1.2	135.5
Natural gas-fired						
Conventional combined cycle	87	15.8	1.7	48.4	1.2	67.1
Advanced combined cycle	87	17.4	2.0	45.0	1.2	65.6
Advanced CC with CCS	87	34.0	4.1	54.1	1.2	93.4
Conventional combustion turbine	30	44.2	2.7	80.0	3.4	130.3
Advanced combustion turbine	30	30.4	2.6	68.2	3.4	104.6
Advanced nuclear	90	83.4	11.6	12.3	1.1	108.4
Geothermal	92	76.2	12.0	0.0	1.4	89.6
Biomass	83	53.2	14.3	42.3	1.2	111.0
Non-dispatchable technologies						
Wind	34	70.3	13.1	0.0	3.2	86.6
Wind offshore	37	193.4	55.4	0.0	5.7	221.5
Solar PV[1]	25	130.4	9.9	0.0	4.0	144.3
Solar thermal	20	214.2	41.4	0.0	5.9	261.5
Hydro[2]	52	78.1	4.1	6.1	2.0	90.3

Table 2: Estimated US average levelised costs (2011$/MWhr) for plants entering service in 2018, from US-EIA (2013)

Dispatchable v Non-Dispatchable Energy

Geothermal power provides a stable and constant source of energy. Unlike solar and wind power, which are intermittent and dependent on weather conditions, geothermal power plants operate consistently. They deliver electricity 24/7, regardless of the weather or time of day, providing a reliable and consistent energy supply.

Energy generation can be split into two different groups:

- **Dispatchable** – being energy sources which can be turned on and off within a short period of time, and the amount of energy they produce can also be turned up or down so that supply of electricity matches the amount demanded by users.

- **Non-dispatchable** – Renewable energy sources which are intermittent, the energy they produce varies from moment to moment, from day to day, and even from season to season. Supply is available when supply is available and if the demand is not there, then the energy can be wasted.

Geothermal is considered dispatchable as it is easily programmed on demand to produce steady reliable energy.

Capacity Factor

The Capacity Factor of a generating unit is the ratio of the electrical energy produced by the unit for the period of time to the electrical energy that could have been produced at continuous full power operation during the same period. Geothermal generation typically operates at a very high Capacity Factor, several times higher than intermittent renewable generators and higher even than conventional coal and gas generators.

Using the data in Table 2, geothermal power plants have an average capacity factor of 92%, meaning that geothermal generators can be expected to reliably produce power for 92% of the time. Geothermal energy is more consistently delivered than both coal and gas generation, and is significantly more reliable than intermittent renewable generation, 170% more than wind and 270% more than solar PVs. The Capacity Factor is a major factor in the Levelised Cost of Energy (**LCOE**), by which measure geothermal energy is one of the cheapest sources of energy, let alone renewable energy.

Levelised Cost of Energy

The LCOE is expressed in $/MWh and is defined as the time-discounted cost to generate energy over the expected lifetime of the generator, divided by the amount of energy generated over the lifetime of the generator, and can be expressed as a formula:

$$\text{LCOE} = \frac{\sum_{t=1}^{n} \frac{I_t + M_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

I_t : investment expenditures in the year *t*
M_t : operations and maintenance expenditures in the year *t*
E_t : electrical energy generated in the year *t*
r : discount rate
n : expected lifetime of system or power station

The key factor in favour of geothermal energy is its very high capacity factor.

A geothermal generator will produce on average 270% more electricity over a year than a solar PV plant of the same installed capacity. The graph in Figure 4, from ARENA[4], shows that Hot Sedimentary Aquifer (HSA) geothermal energy is amongst the lowest LCOE of any renewable energy option for 24-hour supply, lower in fact than stand-alone non-dispatchable wind and Utility PVs.

[4] ARENA 2018 Report – "Comparison of Dispatchable Renewable Electricity Options – Technologies for an orderly transition"

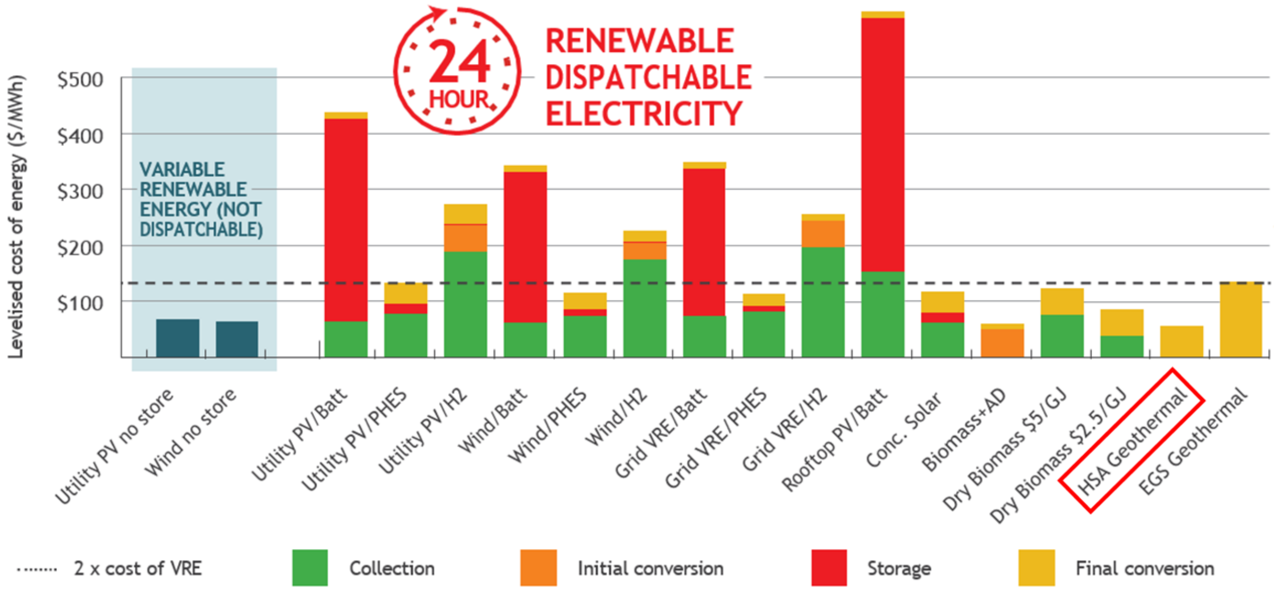
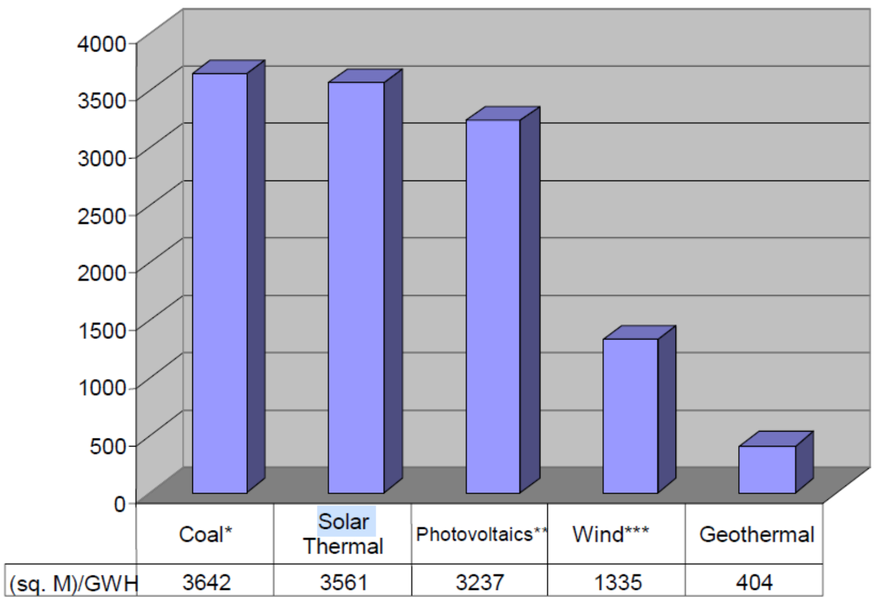


Figure 4: Levelised Cost of Energy for 24 hours duration delivery for systems at 100Mwe nominal capacity evaluated with a 6.5% weighted average cost of capital.

Environmental Impact

Geothermal power plants can be designed to “blend-in” to their surroundings, more so than many other types of electricity-producing facilities. Geothermal power has a small footprint compared to other renewable energy sources and does not require significant alterations to the landscape. Figure 5 shows the land area required to generate 1GWh of energy[5].



* Includes mining.
**Assumes central station photovoltaic project, not rooftop PV systems.
*** Land actually occupied by turbines and service roads.

Figure 5: Land area required to generate 1GWh of energy.

[5] A Guide to Geothermal Energy and the Environment - Alyssa Kagel, Diana Bates, & Karl Gawell, Geothermal Energy Association, April 2007.

Geothermal development poses only minimal impact to wildlife and vegetation in the surrounding area. Unlike solar PV, there is no ground shading, and geothermal avoids the risk to bird life posed by large scale wind farms.

Australian Industry Geothermal Projects

Geothermal energy projects in Australia have been largely confined to smaller scale localised heating projects such as hotel, aged care facilities, public swimming pools, aquaculture, space heating and spa resorts. Recently, however, there is a resurgence of interest in power generation. There are three ASX listed companies pursuing geothermal power generation as an energy source for an ultimate downstream processing goal. These are Vulcan Energy (**Vulcan**) (ASX:VUL), Controlled Thermal Resource (**CTR**) (not listed on ASX) and Strike Energy (**Strike**), (ASX:STX). Vulcan and CTR are both planning to produce geothermal power and recover lithium from hot brines in a carbon neutral process. The Vulcan project is in the Upper Rhine Valley in Bavaria and the CTR project is in the Salton Sea geothermal field in California, USA.

The Strike project is most relevant geographically and technically to the VRX geothermal project. Strike is an ASX listed energy company with an approx. $1bn market capitalisation, that has onshore gas reserves in the Perth Basin. Strike is currently developing a production facility at Walyering in 2023, followed by gas production at South and West Erregulla in 2024 and 2025. In addition to its gas assets Strike is investigating the potential production of Urea via the Project Haber site west of VRX's Arrowsmith North silica sand project. Project Haber envisages using gas from the Erregulla gas field, potentially with geothermal energy to produce low carbon urea for the domestic and export market.

On 17 May 2021 Strike announced the completion of the acquisition of Mid West Geothermal Power Pty Ltd[6], giving access to explore an area of ~4,000km2 in the Dongara region for potential geothermal energy. In April 2022 Strike announced it had received a $2 million grant from the WA Government - Clean Energy Future Fund[7] to support the preparation and execution of a drill test hole. On 5 May 2022 Strike then announced an Inferred Resource for the Mid-West Geothermal Power Project[8], Table 3 summarises the Inferred Resource.

Kingia Sandstones (30-year model)		**P90 (low)**	**P50 (mid)**	**P10 (high)**
GEP Application Area	Mapped Area (km²)	1,826		
	Net Energy Resource (PJe)	69	203	422
	Equivalent Power Resource (MWe)	77	**226**	470

Table 3: Strike – Geothermal Inferred Resource Statement

Strike's inferred resource assessment predicts that if a hot sedimentary aquifer (brine) reservoir is verified there is a 50% likelihood it could support a commercial scale geothermal generating capacity of 226MW total generating capacity over a 30-year period. To put this potential in perspective against other renewable energy generation, an equivalent solar PV array would need to have 270% greater installed capacity to account for the difference in capacity factor.

[6] STX: ASX announcement of 17 May 2021, "Geothermal acquisition progresses to completion"
[7] STX: ASX announcement of 8 April 2022, "Strike Awarded Clean Energy Future Fund Grant"
[8] STX: ASX announcement of 5 May 2022, "Mid-West Geothermal Power Project Inferred Resource"

This would need the solar array to have an 840MW installed capacity, which would have a footprint of 590Ha compared to a 74Ha geothermal plant. The solar array would only produce power 25% of the time compared to 92% for the geothermal plant.

It should be noted that Vulcan and CTR are both looking at extracting significant value from the minerals contained within the hot sedimentary hosted brine. In both cases the final product is lithium, a high value battery mineral. VRX will assess the potential for secondary revenue streams from brine minerals, however Strike has not reported any such potential in its own fields to date.

Uses for Renewable Geothermal Energy

Baseload grid power

As shown on Figure 1, GEP 44 is traversed by 330KV and 132KV transmission lines that are connected to the South West Interconnected System (**SWIS**) and an associated substation. The presence of this infrastructure could allow for any excess electricity generated to be fed into the SWIS as base load grid power. In addition to this the immediate area has 2 long life mineral sands mines, Iluka Resources Cataby Mine and Tronox Inc. Cooljarloo Mine, both of which consume significant power.

Hydrogen injection in Gas Pipelines

The WA Government as part of its decarbonizing strategy has successfully completed studies confirming the technical feasibility of transmitting hydrogen via the existing gas pipelines by either blending[9] with natural gas or 100% hydrogen[10]. GEP44 has both the Parmelia and Dampier to Bunbury pipelines running through, or proximal to them, Figure 1.

Green Hydrogen

A potential use of the energy that could be generated from a Geothermal Plant is the production of green hydrogen. In March 2022 VRX announced[11] an MOU with Xodus Group for potential supply to a glass manufacturing facility powered by hydrogen producing ultra-clear glass for solar panels from the high-grade silica sand produced from VRX's Muchea silica sand project. The MOU covered a possible future offtake of 9,000 tonnes to 11,000 tonnes of hydrogen per annum. If a geothermal resource is delineated leading to development of a commercial scale power generator, all or some of the power generated could be used to produce green hydrogen by the electrolysis of water. Recently Hysata, in Wollongong NSW, achieved a record-breaking reduction in the energy required to produce hydrogen by 20% to 41.4kWh/kg[12]. To put this potential in scale, a 100MW installed geothermal generator could potentially produce 20,000t of hydrogen per annum. Any green hydrogen produced could potentially be injected into the gas pipeline that runs through the GEP 44 area or potentially supplied to hydrogen vehicles travelling along Brand Highway.

This announcement has been authorised for release to ASX by the Managing Director, Bruce Maluish.

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[9] https://www.gtlaw.com.au/knowledge/only-pipe-dream-report-hydrogen-gas-blending-dbngp
[10] https://www.wa.gov.au/government/media-statements/McGowan-Labor-Government/Study-proves-feasibility-of-gas-to-hydrogen-pipeline-conversion-20230519
[11] ASX announcement of 9 March 2022, "Hydrogen Supply MOU with Xodus Group"
[12] https://hysata.com/news/hysata-delivers-the-step-change-needed-in-electrolysis/

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About VRX Silica Limited

VRX Silica Limited (ASX: VRX) is the most advanced pureplay silica sand company listed on the ASX, developing its 100% owned silica sand projects at Arrowsmith (North, Brand and Central), Muchea and Boyatup in Western Australia.

Silica sand is the most used commodity on the planet after air and water. It is the main ingredient in all types of glassmaking, including specialty solar panel and high-tech glass, and foundry casting. It is a finite resource that is running out, with the Asia-Pacific region experiencing an ever-growing supply shortfall that is driving up prices.

Arrowsmith is located 270km north of Perth. Arrowsmith North boasts a minimum 25-year mine life capable of producing more than 2Mt tonnes per year of high-grade (99.7% SiO_2)* silica sand for export to the foundry, container glass and flat glass markets in Asia, with permitting well advanced, and will lead production.

Muchea, located 50km north of Perth, is an ultra-high-grade (99.9% SiO_2)* silica sand project capable of producing sand required for ultra-clear glass for solar panels and other high-tech glass applications.

Boyatup, located 100km east of Esperance, is under development and capable of producing sand for the glass market.

*Information relating to grades are extracted from releases to ASX on 28 August 2019 and 11 November 2022 (Arrowsmith North) and 18 October 2019 (Muchea). The company is not aware of any new information or data that materially affects this information.