

Equity Research



Vulcan Energy Resources Limited

Initiation of coverage

4 March 2020

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Investment recommendation:

Buy

(Initiation of coverage)
**Price target: AUD 2.45/
EUR 1.45**
(Initial assessment)
Stock exchange: Australian Stock Exchange

Reuters: VUL.AX

Bloomberg: VUL:AU

Dual listing
Stock exchange: Frankfurt Stock Exchange

Reuters: 6KO.DE

Bloomberg: 6KO:GR

ISIN/WKN: AU0000066086/A2PV3A

Market capitalisation: AUD 13.00 million

EUR 8.61 million

Number of shares: 54,15 Mio. (undiluted)

Shareholder structure:

Dr Francis Wedin, MD 20.62%

Gavin Rezos 6.80%

Dr Horst Kreuter 1.02%


Closing price ASX (04/03/2020):

AUD 0.24

High/low ASX 52 weeks:

AUD 0.38 / AUD 0.12

Closing price Frankfurt (03/03/2020):

EUR 0.159

High/low Frankfurt since 04/12/2019:

EUR 0.220 / EUR 0.089

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Vulcan Energy Resources Limited

Zero-carbon lithium production within reach

The Australian exploration company **Vulcan Energy Resources Ltd.** has turned its attention to the exploitation of lithium resources in the Upper Rhine Valley, which are also generous by global standards. The concept: to combine the use of thermal water as an energy source (hydrogeothermal energy) with the extraction of the lithium contained in the lithium-rich geothermal brine without polluting the environment with emissions, waste material or toxic substances. With a CO₂ footprint of "zero", the project is predestined to mark the beginning of the decarbonization of the battery industry.

Most of the projects that competitors are planning for Europe involving the mining of the raw material lithium come with a drawback. As a result, even by the end of the decade, Europe is likely to only have come marginally closer to its goal of establishing an independent lithium supply chain, an objective that is guided by two key aspects: 1) strategic supply security and 2) keeping any emissions that are harmful to the climate and the environment to a minimum. By contrast, we consider the prospects of the Upper Rhine Valley project being implemented successfully to be plausible. In our view, lithium hydroxide/LiOH production of an initial volume of 1.5 thousand t from 2023, and 25 thousand t from 2025 onwards, is a secure baseline scenario.

The Upper Rhine Valley will be accelerated by the cooperation with a German geothermal power plant operator. Pursuant to a Memorandum of Understanding concluded in November 2019, **Vulcan Energy Resources** will base the pilot plant for lithium production at a geothermal power plant already in operation (stage 1). This will shorten the process involved in both exploration for geothermal energy use and the construction of the geothermal power plant. Implementation will require **Vulcan Energy Resources** to finance funds in an amount that we estimate to come to around USD 55 million.

In parallel with stage 1, the "Greenfield Project" in Ortenau will be developed as the second stage (stage 2) of the development of a lithium extraction facility in the Upper Rhine Valley. The outlay required for the first resource estimate (December 2019) was comparatively low, as the company was able to use freely available data, or data available for purchase, to document, among other things, the prevalence of lithium-rich thermal waters. Based on a lithium concentration estimated at 181 mg/l, a resource estimate of a total of approx. 13.9 million t lithium carbonate equivalent/LCE has been indicated for the Upper Rhine Valley Project, which has so far been defined as Stage 1&2 (JORC-compliant: Inferred Mineral Resource, not Mineral Reserve). This puts **Vulcan Energy Resources** at the very top of the rankings for the peer group of exploration projects in Europe – all of which are based on hard rock deposits.

Irrespective of how the supply and demand situation in Asia will develop: securing the raw material supply for Europe's battery industry is a challenge that puts a European lithium producer in a strong position. In actual fact, we assume, for the purposes of the baseline scenario that we have applied, that lithium hydroxide produced free of CO₂ emissions in a core industrial region of Europe will benefit from a relevant premium on the reference price calculated for Asia. The European battery industry, which is currently in the process of expanding, will have strong incentives to use the raw material extracted by **Vulcan Energy Resources**.

Following the start-up phase (2022 to 2023), which is characterised by capex, amortisation will be achieved within four years. Raising the capital remains a key aspect for the implementation of the zero-carbon project in the Upper Rhine Valley - while the funds required for Stage 1 remain relatively lean at around USD 55 million. By discounting our modelled cash flow projection, we consider an enterprise value of USD 769 million to be appropriate.

We have set a price target of EUR 1.45 (equivalent to AUD 2.45) for shares in Vulcan Energy Resources. The investment recommendation for the initial assessment is "buy".

2. The idea: Environmentally neutral lithium mining from thermal water in the Upper Rhine Valley

The Australian exploration company **Vulcan Energy Resources Ltd.** has turned its attention to the exploitation of lithium resources in the Upper Rhine Valley, which are also generous by global standards. The concept: to combine the use of thermal water as an energy source (hydrogeothermal energy) with the extraction of the lithium contained in the lithium-rich geothermal brine without polluting the environment with emissions, waste material or toxic substances. Lithium is the critical raw material for electrifying transport. The thermal water in the Upper Rhine Valley has a content of up to 210 mg/l – the only other known geothermal field with similar lithium grades and a similar flow rate is Salton Sea, California.

From the French-German border region between the Vosges and the Black Forest, the Rhine plains of the Palatinate to the north and at the mouth of the Neckar River, geothermal anomalies can be found which can be used commercially for heat and electricity supply. This is evidenced by the geothermal power plants in Bruchsal (since 2009, operator: *EnBW*), Insheim (since 2012, operator: *Pfalzwerke*) and Soultz-sous-Forêts (since 2017, operator: the EDF subsidiary *Electricité de Strasbourg* together with EnBW).

Various cost advantages owing to geological factors point to the economic viability of the lithium project in the Upper Rhine Valley; in addition to the lithium content and a high flow/production rate achieved there (example: Insheim geothermal power plant: 67 l/s, potential capacity: 85 l/s), the energy required for the extraction process is significantly lower thanks to what is already a high starting temperature of over 120°C.

The most important aspect, however, which also combines cost-effectiveness considerations with the aspect of minimising the "footprint" in terms of the environmental impact, is the immediate proximity to industrial customers. The transportation distance of a few hundred kilometres to existing or planned battery factories and the industrial mobility cluster in the south-west of Germany is a decisive argument that helps to underpin the advantages associated with the carbon footprint of the electric drive versus the combustion engine.

The need for electric drive systems to have a superior carbon footprint in the production phase, too, is a key aspect, and one that has the very highest priority. The supply security argument is also a top priority. For industrial and security policy reasons, Europe has to manage to break away from its current 100% reliance on raw material supplies from South America or Asia.

Zero-carbon project

Carbon footprint

- "Zero" on the production side thanks to the advantage of a simple process
- Logistics: Immediate proximity to customers

3. Supply projection: No prospect of lithium hydroxide demand being sufficiently covered by European production

The key projections for mobility development over the coming decades are based on electric drive systems as the successor to the combustion engine. Vehicle manufacturers across the globe are focusing on the lithium-ion accumulator (rechargeable battery) as an energy storage device and have established it as the standard, whereas the alternative of using fuel cells, which generate electrical energy from hydrogen, will likely be limited to heavy-duty traffic on an industrial scale.

The lithium component is indispensable for all battery technologies that are industrially relevant at present. Ensuring that the demand for lithium-ion accumulators for the automotive industry is covered is a matter that has been assigned a high level of priority throughout Europe. Industrial policy ambitions are therefore aimed at establishing a consistently European supply chain. In Germany alone, there are plans to make investments running into the billions in factory complexes for battery cell production. In addition, industrial policy initiatives include the mining of the raw material lithium – which never occurs as a pure element in nature due to its high reactivity – and the processing of the ores/brines.

Particularly in the south-west of Australia, the mineral spodumene ($\text{LiAlSi}_2\text{O}_6$) is mined from hard rock deposits in the region's pegmatite fields (pegmatites belong to the group of magmatic dyke rocks). The majority of the quantities extracted are shipped as concentrate for processing to China, where they cover 75% of the country's lithium requirements; only China has the infrastructure required to break large quantities of concentrate down using metallurgical processes. Established production processes initially produce lithium carbonate (Li_2CO_3). Lithium carbonate is the feedstock used for the production of lithium hydroxide (LiOH), and also for the production of other intermediates such as lithium chloride (LiCl). Processing in the battery industry requires lithium carbonate purities of 99.5% or more. The conversion factor LCE (Lithium Carbonate Equivalent), which is common in international trade, refers to lithium carbonate.

Even more significant on a global scale are the deposits of the light metal lithium in salt lakes in South America ("Lithium Triangle" in the Argentina-Bolivia-Chile border region), North America (Nevada, Utah, Searles Lake and Salton Sea/California) and China (Tibetan Plateau). Lithium carbonate and lithium hydroxide is produced from lithium chloride which is extracted from the brines.

By separating lithium from thermal water in the Upper Rhine Valley, **Vulcan Energy Resources** is planning to achieve a zero-emissions, cost-effective way of extracting lithium hydroxide. Other lithium deposits in Europe are hard rock deposits in pegmatite fields containing spodumene, or in which lithium is bound in certain mixed crystals, such as zinnwaldite ($\text{KLiFe}^{2+}\text{Al}(\text{AlSi}_3)\text{O}_{10}(\text{F},\text{OH})_2$) and other mica.

Spodumene ore mining projects are being pursued near Wolfsberg in eastern Carinthia (operator: *European Lithium*), near Kaustiselta in the Finnish Pohjanmaa belt (operator: *Keliber*) and near Alturas do Barroso in Portugal's northern district of Vila Real (operator: *Savannah*).

Projects in the Czech-German border region of the Erzgebirge Mountains (operated by *European Metals* in Cínovec, Czech Republic) and near Cáceres in the Spanish province of the same name (operated by *Infinity Lithium*) are aimed at the commercial mining of zinnwaldite and its processing to produce lithium hydroxide. Processes for the extraction of lithium from zinnwaldite – which has a relatively low lithium content (approx. 3% Li_2O , percentage of Li by mass: approx. 1.5%), but a high content of iron oxide (approx. 11% FeO , approx. 2% Fe_2O_3) and fluoride (approx. 6%), as well as aluminium - have not yet been implemented on an industrial scale.

Another approach to lithium mining in Europe is the mining of the mineral jadarite ($\text{LiNaSiB}_3\text{O}_7(\text{OH})$) near Loznica in the Serbian district of Mačva (operator: *Rio Tinto*). Both the high lithium content (approx. 7% Li_2O , percentage of Li by mass: approx. 3%) and the prospect of the commercial extraction of boron are attractive aspects.

Most of the projects come with a drawback. As a result, even by the end of the decade, Europe is likely to only have come marginally closer to its goal of establishing an independent lithium supply chain, an objective that is guided by two key aspects: 1) strategic supply security and 2) keeping any emissions that are harmful to the climate and the environment to a minimum.

The drawback regarding the extraction of lithium from spodumene mined in Europe will be the fact that the concentrate will first of all have to be transported to China for processing – a considerable disadvantage in view of the climate policy benefits of electromobility. China's large-scale spodumene conversion plants are operated in particular by *Ganfeng Lithium*, *Tianqi Lithium*, *Yahua Lithium* and *General Lithium*; additional capacity in the south-west of Australia (current ramping up of the *Tianqi Lithium* plants in Kwinana, plants of the US *Albemarle* in Kemerton with production scheduled to start in 2023, both companies – *Tianqi* and *Albemarle* – already provide limited processing capacity on location through their subsidiary *Talison*) will remain irrelevant for the processing of European spodumene concentrates.

There has been no industrial capacity for processing zinnwaldite to date. The process capacities planned at the mines on location in Cínovec and at Cáceres require substantial investment, albeit significantly lower investments than corresponding plants for processing spodumene. The increased prospects, on the other hand, of corresponding processing plants also being available in Germany in a few years' time are explained by the parallel suitability of the relatively simple chemical process for recycling old lithium batteries. According to the PFS (pre-feasibility study), *European Metals* has to budget for at least USD 105 million in Cínovec for crushing and ore processing technology, and at least USD 265 million for lithium hydroxide production (also for underground mining: USD 70 million, indexed annual production: 25.3 thousand t, equivalent of 22.5 thousand t p.a. LCE). According to the PFS, the start of lithium hydroxide production by *Infinity Lithium* in Cáceres will require the investment of at least USD 268 million, most of which has been planned for the processing stage (low investment share for opencast mining, indexed annual production: 16.5 thousand t, equivalent of 14.3 thousand t p.a. LCE).

The prospect of processing the jadarite to be mined in Serbia depends on the commitment made by *Rio Tinto* – after all, exploration activities had already used up USD 100 million by mid-2018. *Rio Tinto* has built a pilot plant for the extraction of lithium and boron from jadarite in Bundoora near Melbourne.

Direct lithium extraction

- Time factor: Lithium is separated within a matter of hours
- Reliable: External interference factors, especially due to weather events, are largely eliminated

By contrast:

- Complex mechanical and chemical separation of hard rock deposits
- As a preliminary stage of chemical treatment in large-scale plants, brine deposits pumped from the groundwater of salt lakes have to be subjected to an evaporation process in successive basins over a period of months

4. Advantage thanks to process engineering innovation

Overall, the traditional production of lithium from brines pumped up from the groundwater of salt lakes in South America, China or California is even more capital-intensive than production from hard rock. This is due less to a large-scale plant capacity that is essentially comparable to separation from hard rock ores, but rather to the substantial initial costs of capacity ramp-up or expansion (the process of lithium enrichment of the brine takes up to 18 months). On the other hand, the extraction of lithium from brine deposits is characterised by low variable operating costs. Process engineering innovations extend this operating cost advantage even further. They address the obstacle that brines that are conventionally pumped to the surface are first of all concentrated in successive evaporation basins for prolonged periods.

The US lithium specialist *Livent* (spun off from the *FMC Corp.* group in two stages in 2018 and 2019) uses an upstream adsorption plant for brine extracted from the Salar del Hombre Muerto (Argentina) to remove detrimental impurities (Ca, Mg, Na). For more than 20 years now, this process technology prototype, known as direct lithium extraction (DLE), has proven effective in industrial lithium carbonate production at the Fénix site (2019: 20 thousand t LCE, followed by lithium hydroxide production at sites in the US and China, 22 thousand t). Two DLE plants are currently in operation in China.

The DLE processes need to be mastered to fulfil the technical prerequisites for the cost-effective exploitation of existing lithium deposits from hot, mineral-bearing deep waters at geothermal energy production sites, too.

With strategic links to *Livent*, the Canadian company *E3 Metals Corp.* has technical expertise regarding DLE. *E3 Metals* plans to produce 20 thousand t of LCE from brine deposits in Alberta using the ion exchange process for raw material extraction.

The Featherstone geothermal power plant in Salton Sea, California, is the first pilot plant for the separation of lithium from thermal water in the trial phase of commercial use. The plant is operated by *EnergySource*, a local player. After the ramp-up phase, which is scheduled to begin in 2023, the aim is to produce 16 thousand t of LCE, with the total investment calculated to amount to USD 350 million. *Berkshire Hathaway Energy (BHE)* operates ten additional geothermal power plants in the Salton Sea's Imperial Valley, and the search for a partner that could develop the site-specific expertise for DLE is under way.

Basically, **Vulcan Energy Resources** is not committed to using a specific DLE process for the extraction of lithium from the thermal water in the Upper Rhine Valley, but rather can opt to use the process that is considered ideal in light of the regional conditions.

For projects that are to be tackled next, the first step involves removing the lithium from the brine using an absorbent. The second step involves forced evaporation within a closed cycle to enrich the lithium. Once the DLE process is complete, **Vulcan Energy Resources** plans to convert the lithium into lithium hydroxide in the actual "lithium plant".

5. Lithium extraction in the Upper Rhine Valley: low capital intensity, capital investment pays for itself within a short space of time

According to our assessment of **Vulcan Energy Resources'** plans, DLE based on deep aquifers for hydrothermal use is characterised by comparatively low capital-intensity. The infrastructure for lithium separation requires lower investments and less working capital. The energy made available in a geothermal process covers the requirements of the energy-intensive raw material extraction processes. A large part of the investments, which are a prerequisite for lithium production in the Ortenau (stage 2), will be used for geothermal power plant capacity.

Another advantage of **Vulcan Energy Resources'** intended separation from thermal water in the Upper Rhine Valley, compared to other financing projects, is the short period in which the capital expenditure will pay for itself. The exploration of the lithium reserves in the Upper Rhine Valley, on which excellent geological data is available, is already a process involving a low level of complexity, as the resource calculation is based on the processing of data that is already available.

6. Upper Rhine Valley project implementation: Exploration licenses and cooperation with established geothermal power plant

Key individuals

- Dr Francis Wedin, Managing Director: Entrepreneurial expertise in the field of lithium exploration with a track record spanning four continents
- Gazin Rezos: Expertise in investment banking and as Executive Chair/CEO of two high-growth companies listed on the ASX 300
- Dr Horst Kreuter: Co-initiator of the Upper Rhine Valley project, managing director of GeoThermal Engineering GmbH in Karlsruhe, decades of entrepreneurial experience and political activities within associations (German Geothermal Association, Bundesverband Geothermie)

With the recruitment of Dr Horst Kreuter, **Vulcan Energy Resources** has managed to involve an eminent name within the European geothermal energy segment - as an entrepreneur, scientist and lobbyist (German Geothermal Association) - in the lithium project. With his technical and mining law expertise, Kreuter has advanced the process that is designed to result in industrial infrastructure with combined hydrogeothermal use and lithium extraction. The exploration and development project in the Upper Rhine Valley, registered under company law as **Vulcan Energy Resources Pty Ltd.**, was taken over in full by **Koppar Resources Ltd.** in 2019, which subsequently changed its name to **Vulcan Energy Resources Ltd.** in November 2019.

Two exploration licenses (mining exploration licences) were granted in the first half of 2019, and applications for three more have been submitted to date (applications submitted by **Vulcan Energy Resources Pty Ltd.**). The licence for "exploration of the mineral resources of geothermal energy and other energies, brine and lithium occurring in connection with the extraction process" in the Ortenau licence area was granted on 1 April 2019 by the Baden-Württemberg State Authority for Geology, Mineral Resources, and Mining (responsible for depths of 100 m and more), which forms part of the Freiburg Regional Council. It applies for an initial period of two years. A corresponding concession for Mannheim was obtained on 18 June 2019.

The Upper Rhine Valley will be accelerated by the cooperation with a German geothermal power plant operator. Pursuant to a Memorandum of Understanding concluded in November 2019, **Vulcan Energy Resources** will base the pilot plant for lithium production at a geothermal power plant already in operation. (mining licence granted until 2037). This will shorten the process involved in both exploration for geothermal energy use and the construction of the geothermal power plant.

MoU with Local Operator

- Time and risk factor:
Exploration, approval procedures and construction of geothermal power plant already completed
- Capital required for pilot plant reduced considerably

Subject to a final contractual agreement to establish the joint venture, a financial share of 80% from the mining rights to the lithium reserves is being granted to **Vulcan Energy Resources**. The Geothermal power plant operator will opt for a licensing model (income from a financial share of 20%) or pro rata project participation (including investment budget) once the detailed feasibility study is available.

By including the established geothermal site as a pilot plant, the zero-carbon lithium project gains a time advantage and the initial capital requirement is considerably lower. Risks associated with a mining project in central Europe that are difficult to calculate arise due to the numerous regulatory hurdles that the approval process presents at various stages. By building on an established geothermal site, hurdles regarding the approval of the exploration progress and power plant construction have been successfully eliminated.

7. "Brownfield" shortcut – existing energy plant to be extended to feature lithium separation plant

A start-up period running until 2023 has been planned until direct lithium extraction (DLE) goes into operation in stage 1. Based on a lithium concentration of 181 mg/l, an inferred mineral resource of approximately 722 thousand t of lithium carbonate equivalent (LCE) has been estimated for this established geothermal site (December 2019, also: Scoping Study, February 2020).

Upper Rhine Valley resource estimate (established power plant site, Ortenau)

		Stage 1	Stage 2 Ortenau	Stages 1 + 2	- not to be included yet - Mannheim and others ^(*)	
					min	MAX
Total Volume of Brine Aquifer	km ³	8,322	144,489		92,422.460	138,633.690
Average Porosity		9.000	9.500		7.600	11.400
Average concentration	mg/l	181	181		126.000	190.000
total elemental Li	mg	13,556,538	248,448,836		88,503,748	300,280,573
total elemental Li	t	136	2,484		885	3,003
Elemental Li	t	136.000	2,484.000	2,620.000	885.037	3,002.806
Lithium Carbonate LCE	t	723.969	13,223.077	13,947.046	4,711.320	15,984.836
Lithium hydroxide	t	822.249	15,018.138	15,840.387	5,350.892	18,154.811
Lithiumoxid	t	292.808	5,348.052	5,640.860	1,905.486	6,465.041

^(*) others: Taro, Ludwig, Rheinaue

Source: Vulcan Energy Resources, SRH AlsterResearch

The yield is determined by the lithium content and the flow rate. The flow/production rate from the well is defined as 67 l/sec for the established power plant. In our view, lithium hydroxide/LiOH production of 1.5 thousand t from 2023 onwards represents a secure baseline scenario for the site. The availability of the power plant came to 7,416 operating hours in 2018 (2017: 7,744 h), achieving a capacity utilisation rate of 84.6% (previous year 88.4%). In our projection, we have assumed a capacity utilisation rate of 90%.

Volume yield estimate Upper Rhine Valley (established power plant site, Ortenau)

		Stage 1	Stage 2 Plant 1 Ortenau	Stage 2 Plant 2 Ortenau	Stage 2 Ortenau	Stages 1 + 2
number of wells (doublets)		1	4	6	10	11
Flow rate per well	m ³ /a	2,112,912	2,680,560	2,680,560		
	l/a	2,112,912,000				
	l/d	5,788,800				
Approach: 8,760 h/anno	l/h	241,200				
	l/s	67.000	85.000	85.000		
average concentration	mg/l	181	181	181		
Day factor (7,884 h of 8,760 h)		0.90	0.90	0.90		
plant recovery		0.900	0.900	0.900		
Share VUL	mg/l	80%	100%	100%		
Li/s	mg	7,858	49,847	74,771		
Li/h	kg	28.29	179.45	269.18		
Li/d	kg	679	4,307	6,460		
Li/a	kg	247,819	1,571,988	2,357,981		
Li/a	t	248	1,572	2,358	3,930	4,178
Lithium carbonate LCE/a	t	1,319	8,368	12,552	20,920	22,240
Lithium hydroxide/a	t	1,498	9,504	14,256	23,760	25,259

Source: SRH AlsterResearch

For DLE projects, the geologists involved expect that between 80% to 90% of the lithium contained in the thermal water can be filtered out (similar figures are mentioned in connection with the *E3 Metals* project supported by DLE pioneer *Livent*, among others). Regarding the brines pumped up from the groundwater of salt lakes, a recovery rate of only 50% can be assumed.

We are budgeting around USD 50 million for the direct lithium extraction plant (DLE plant) and for the lithium hydroxide synthesis capacity (lithium plant). We have broken down investment plans for the extraction of lithium from brine deposits (excerpts available, for example, from the feasibility study for Argentina) to suit the scale of stage 1. We have also taken special features of the site (infrastructure, energy supply) into account. Including a standard contingency premium (10% contingency), approximately USD 55 million will have to have been raised by the end of 2022.

Capital requirements stage 1:

USD 55 million

8. Ortenau capacity data

Configuration stage 2:

Power plant 1:4 doublets

- 1 DLE plant
- 1 lithium plant
- "mother plant"

Power plant 2:6 doublets

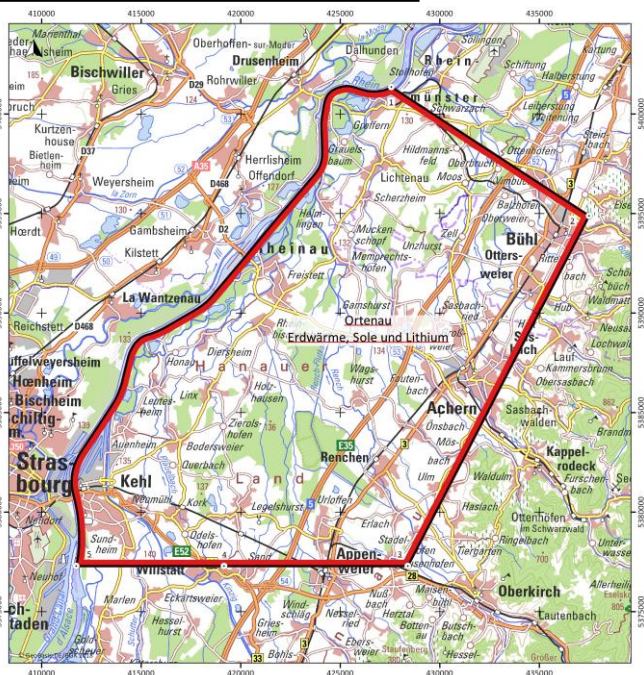
- 1 DLE plant

Transportation of the intermediate to the "mother plant" of power plant 1 (LiOH production)

In order to ensure that the entire Upper Rhine Valley project progresses at a rapid pace, **Vulcan Energy Resources** is initially focusing on the promising Ortenau licence area - summarised in the scoping study as stage 2. Following completion of the exploration phase, the planning process (pre-feasibility study/PFS, detailed feasibility study/DFS) and once all official licences have been granted, two geothermal power plants are to be built in Ortenau, each with one DLE plant. The first power plant is to be equipped with a production capacity of four "doublets" (one extraction and one reinjection well form a doublet) in 2024, the second with a capacity of six doublets.

Lithium hydroxide synthesis is planned for the site of the first power plant. The intermediate from the lithium separation process in the second DLE plant will be transported there using tanker trucks.

The electricity production yield is determined by the flow rate, which we have assumed, in our baseline scenario, to be 2.68 million m³/anno (equivalent of 85 l/sec, in line with a well drilled in Insheim at the beginning of 2009). The flow rate depends on both the rock around the well and on the well itself. Over the past few years, exploration projects within the Ortenau region have resulted in a considerable increase in the empirical knowledge available. The development concept presented by **Vulcan Energy Resources** is far superior to projects that can now be considered historical - downstream on the Rhine, the Bruchsal, Landau and Insheim power plants were commissioned between 2009 and 2014. This superiority relates to the expertise for selecting the target area in the rock, as well as to the methodology for developing the target area (drilling path in the reservoir). Together with the flow rate, the temperature determines the energy that produces the rated output when generating electricity.



The Ortenau region extends along the German side of the Rhine between Kehl and Bühl.

Based on scaling up from 1 production well to 4+6 wells, we set the nominal capacity of the first power plant at 18 MW, that of the second power plant at 27 MW (total annual production, including the amount of energy to be used for lithium production, based on 7,884 operating hours: 355 GWh).

In principle, the exploration risk of geothermal energy in relation to its potential for energy production (electricity and heat) is not the critical variable for the progress of the **Vulcan Energy Resources** project. The planned lithium separation ensures the profitability/return on investment of the power plant operation even at lower production rates.

Based on a lithium concentration that has been estimated at 181 mg/l, a resource estimate of a total of 13.2 million t LCE has been specified for the

Ortenau sites (JORC-compliant: inferred mineral resource, not mineral reserve).

Upper Rhine Valley resource estimate (established power plant site, Ortenau)

	Stage 1	Stage 2 Ortenau	Stages 1 + 2	- not to be included yet - Mannheim and others ^(*)	
				min	MAX
Total Volume of Brine Aquifer	km ³	8,322	144,489	92,422	138,634
Average Porosity		9.000	9.500	7.600	11.400
Average concentration	mg/l	181	181	126	190
total elemental Li	mg	13,556,538	248,448,836	88,503,748	300,280,573
total elemental Li	t	136	2,484	885	3,003
Average Porosity	t	136.000	2,484.000	885.037	3,002.806
Lithium Carbonate LCE	t	723.969	13,223.077	4,711.320	15,984.836
Lithium hydroxide	t	822.249	15,018.138	5,350.892	18,154.811
Lithiumoxid	t	292.808	5,348.052	1,905.486	6,465.041

^(*) others: Taro, Ludwig, Rheinaue

Source: Vulcan Energy Resources, SRH AlsterResearch

The yield is determined by the lithium content and the flow rate. In our view, lithium hydroxide/LiOH production of 24 thousand t from 2024 onwards represents a secure baseline scenario for stage 2.

Volume yield estimation Ortenau

	Basic scenario			Alternative scenario ^(*)	
	Stage 2 Plant 1 Ortenau	Stage 2 Plant 2 Ortenau	Stage 2 Ortenau	Stage 2 Pl. 1 Ortenau	Stage 2 Pl. 2 Ortenau
number of wells (doublets)	4	6	10	4	6
Flow rate					
per well	m ³ /a	2,680,560	2,680,560	3,153,600	3,153,600
	l/s	85.000	85.000	100.000	100.000
cumulated, all doublets	m ³ /a	10,722,240	16,083,360	12,614,400	18,921,600
	l/s	340.000	510.000	400.000	600.000
average concentration	mg/l	181	181	181	181
Day factor (7,884 h of 8,760 h)		0.90	0.90	0.90	0.90
plant recovery		0.900	0.900	0.900	0.900
Share VUL	mg/l	100%	100%	100%	100%
Li/s	mg	49,847	74,771	58,644	87,966
Li/h	kg	179.45	269.18		
Li/d	kg	4,307	6,460		
Li/a	kg	1,571,988	2,357,981		
Li/a	t	1,572	2,358	1,849	2,774
Lithium carbonate LCE/a	t	8,368	12,552	9,845	14,767
Lithium hydroxide/a	t	9,504	14,256	11,181	16,772

^(*) The alternative scenario is not further explored in our assessment

Source: SRH AlsterResearch

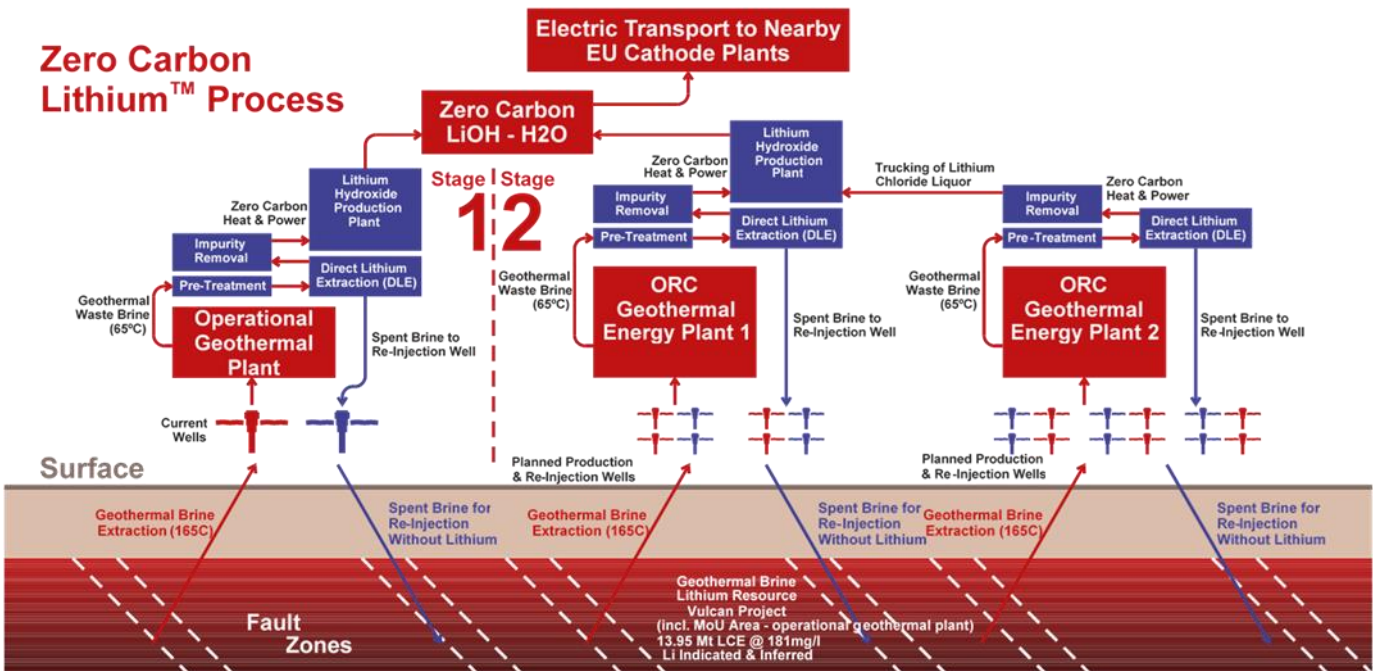
The investment project in Ortenau is divided into five major phases:

- Stage 2 Plant 1
 - Geothermal power plant 1 with four doublets
 - DLE plant
 - Lithium plant
- Stage 2 Plant 2
 - Geothermal power plant 2 with six doublets
 - DLE plant

In order to estimate the capital expenditure for the construction of the geothermal power plants, we have converted current data collected for the Upper Rhine Valley on behalf of the German Federal Ministry for Economic Affairs and Energy to reflect the scale of the Ortenau project (assuming a constant exchange rate of EUR/USD 1.10).

Capital requirements stage 2:
USD 800 million

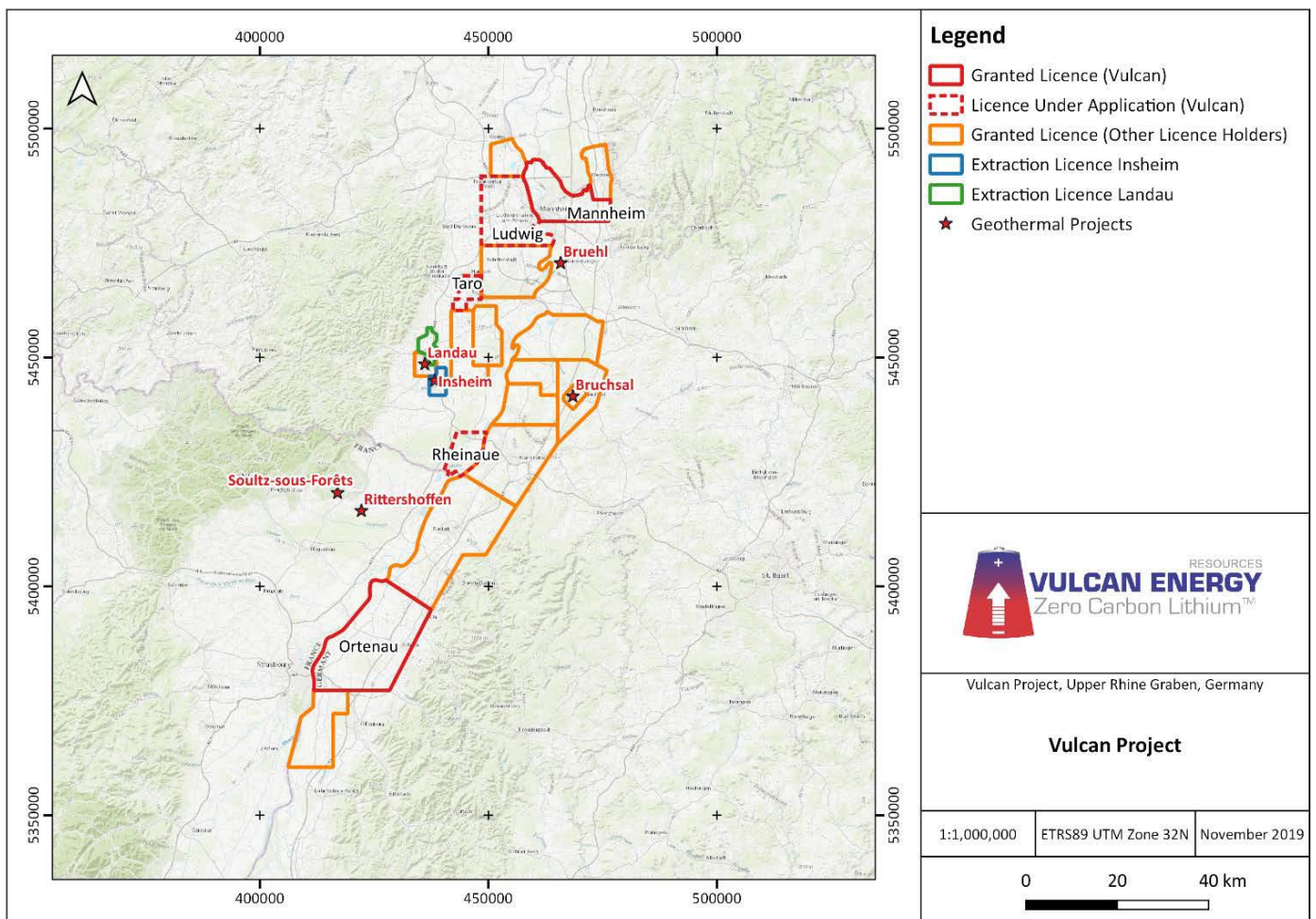
Including the usual contingency surcharge (10% contingency), we estimate that capital of USD 370 million will have to have been raised by the end of 2023 for the two geothermal power plants in Ortenau, with a further USD 420 million being required for two DLE plants and for the lithium hydroxide synthesis capacity (i.e. for stage 2 in total: USD 790 million).



Source: Vulcan Energy Resources, SRH AlsterResearch

9. Implementation of Ortenau exploration project: shortcut thanks to data for comparable drillings ("proxies")

Ortenau is a greenfield project – no existing capacity could be used as a basis and the location decision within the licence area is open. Nevertheless, the outlay required by **Vulcan Energy Resources** for the initial resource estimate (Maiden Mineral Resource Estimation, December 2019) has been comparatively low. This is because distinct seismological data and drilling results from scientific raw material exploration are available for the entire area under investigation in the Upper Rhine Valley. In this respect, the resource estimate was based on freely available geodata or the purchase of existing 2D seismic lines. Vulcan also conducted its own sampling campaign from existing wells, to confirm the lithium grades in the Upper Rhine Valley.



Source: Vulcan Energy Resources

Based on samples from two sampling points each in Insheim and Landau (samples from a fifth sampling point in Brühl were also available), the conclusion reached was that the average lithium concentration in Ortenau is 181 mg/l. This means that the estimate for Ortenau is based on "proxies" from sites located downstream on the Rhine - in methodological terms, this "shortcut" is justified because the concentration levels are considered to be highly consistent within the trench system.

The thermal water flows between the red sandstone in the Upper Rhine Valley at depths between 1,120 m and 4,910 m. For geothermal exploration purposes, deep active fault zones are relevant; considerably fractured and disrupted areas are characterised by increased hydraulic permeability and, as a result, a higher flow rate.

APEX Geoscience created a three-dimensional underground model using the available data. This allowed the size of the cavity (144.489 thousand m³) and the ratio of cavity to total volume (9.5%) to be calculated for the Ortenau deposits.

The further exploration phase will be initiated by supplementary 2D or 3D seismic measurements, if necessary. Finally, on the basis of a refined underground model, target points and the sequence of production wells will be determined.

How a Vulcan Energy Resources hydrothermal power plant works

The system consists of an extraction well and an injection well (doublet). Thermal water is obtained via the extraction well. The reinjection well is used to feed the water back into the reservoir after part of the thermal energy stored in it has been extracted and – based on **Vulcan Energy Resources'** power plant design – after the lithium has been separated. In addition to the two wells, the pump and the pipeline system, the geothermal power plant includes the heat exchanger and the power generation infrastructure based on the heat exchanger. The unit for lithium extraction (DLE plant) is then connected.

There are no plans for extensive exploratory drilling, for which a separate operating plan licence would have to be obtained. On the other hand, the licences for each deep well, the construction of the geothermal power plants and the connected lithium separation plants will have to be obtained. This will require documentation on the exploration activities and proof of financing.

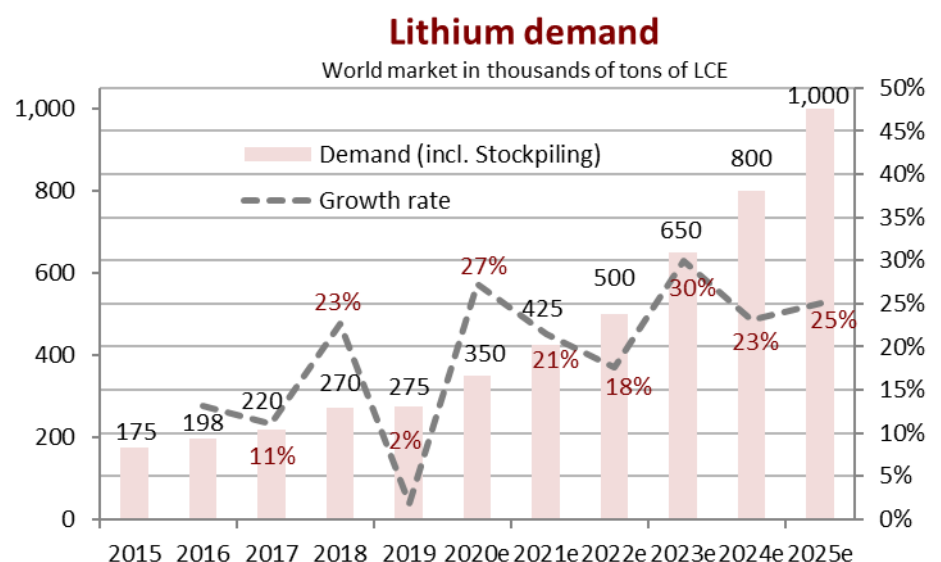
Vulcan Energy Resources is very well positioned in terms of its public relations work on location thanks to Dr Horst Kreuter - this is an important, decisive factor. This is because, in addition to the evidence of technical expertise, commercial soundness and financial scope that has to be submitted to the mining authorities and political decision-makers, communication with the public is a decisive factor in the implementation of the project. Some groups within the population have reservations regarding deep drilling. Bad examples have resulted in a sense of apprehension. Incidents have occurred in the Upper Rhine Valley in the past. Seismic activity was triggered in Landau in 2010 ("micro-earthquake"), although the experience available today shows that this could have been avoided. The incident was caused by pore water pressure increasing when water was injected into deep layers of rock.

There are also concerns regarding the possible contamination of groundwater, although the hydrothermal geothermal energy used does not pose any risks in this respect (and, incidentally, there are none of the pollution risks associated with fracking). The reliability of communication with the local population is an indicator of the prospects of success of the project as a whole.

10. Price forecasts for lithium

The scoping study conducted by **Vulcan Energy Resources** on lithium mining in the Upper Rhine Valley (February 2020) uses Fastmarkets estimates of lithium price developments to project revenue. Fastmarkets also records current price data. At the beginning of 2020, the spot price determined for lithium hydroxide (56.5% battery grade) was in the range of USD 10.00/kg to USD 11.50/kg (cif China, Japan, Korea). The scoping study models revenues from the sale of lithium hydroxide of USD 12.75 thousand/t for 2023, USD 15.63 thousand/t as of 2024 and USD 17.24 thousand/t as of 2029. The forecasts are based on model assumptions regarding the increase in supply, demand and inventories.

Based on the predicted increase in electromobility, annual growth rates in lithium demand (on an equivalent, i.e. LCE basis) of 25% on average (CAGR 2020e to 2025e) are plausible for the next few years – and this very same dynamic, with average growth rates of 25%, is described in estimates of key players (in this case: *Albemarle*) for the supply side, too.



Source: Albemarle (graphic December 2019), Data processing: SRH AlsterResearch

The price increase for lithium products in the course of 2017 (+65%), as well as price declines in 2018 and 2019, also reflected inventory changes along the supply chain and speculative positioning. In 2019, the volume demand within the industrial sector could have increased by up to 35 thousand t of LCE or almost 20%, whereas the quantity called from lithium producers was only just up on the previous year's volume of 5 thousand t of LCE. Whereas stocks in 2018 had still absorbed 30 thousand t of LCE, inventory levels were reduced in 2019.

Our revenue projections assume a lithium hydroxide reference price of USD 12.75 thousand/t in the long term. Irrespective of how the supply and demand situation in Asia will develop: securing the raw material supply for Europe's battery industry is a challenge that puts a European lithium producer in a strong position.

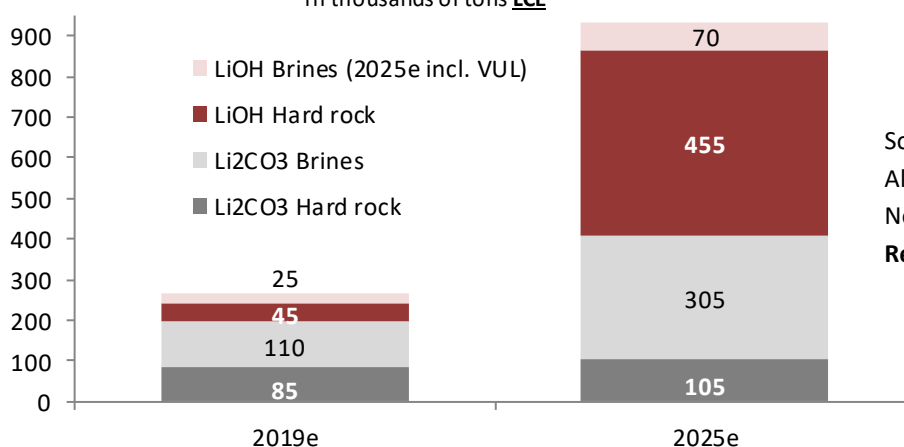
Lithium hydroxide vs. lithium carbonate

Lithium-ion batteries are classified based on the composition of the cathode and anode material used. Market-ready innovations in nickel-cobalt-manganese cathodes, in short: NMC cathodes, currently determine the market momentum. Within this group, low-cost nickel that is readily available in good quantities (here: "N") is replacing manganese (here: "M") and cobalt (here: "C") to a large extent. Whereas the ratio of the first NMC generation was 1:1:1 (NMC 111), the new NMC 622 cathode generation is currently proving increasingly popular. Technically, this requires the use of lithium hydroxide (LiOH) instead of lithium carbonate (Li₂CO₃), insofar as cathode synthesis using lithium carbonate requires high temperatures, which in turn are incompatible with a nickel content of 60% and above (vs. 40% cobalt and manganese). Furthermore, the energy density (or specific energy, energy per mass) of lithium hydroxide exceeds that of lithium carbonate.

According to *Albemarle*'s estimate, LiOH production from hard rock deposits will have increased tenfold by 2025 and will account for 80% of lithium production from hard rock deposits (2019: 35%). LiOH production from brine is forecast to treble, meaning that its share of lithium production from brine will remain at 20%.

Structure of the Li supply

World market by occurrence and product
in thousands of tons LCE



Source:
Albemarle (December 2019)
Note on VUL / **Vulcan Energy**
Resources: SRH AlsterResearch

The CO₂ emissions per unit associated with LiOH production from hard rock deposits will increase sevenfold (in relation to spodumene) compared to the emissions associated with corresponding Li₂CO₃ production; in terms of salt lakes operated in Chile, the emissions per unit produced will double.

11. Cash flow projection

The long-term assumption for the lithium hydroxide reference price determined in Asia (or the price for lithium hydroxide monohydrate: LiOH H₂O) of USD 12.75 thousand/t is a central parameter for the purposes of our revenue projection.

As far as lithium hydroxide production in the pilot plant (stage 1) is concerned, we have applied operating expenses of USD 3.7 thousand/t. We therefore assume that more favourable conditions (geochemical conditions, easy access to infrastructure) will push operating expenses below the level estimated for DLE projects in Salton Sea, California. Over the 30-year period on which the valuation is based, our model results in a yield of 47.9 thousand tonnes of LiOH. Disregarding any discounting effect, capital expenditure payments are mathematically distributed over USD 1.12 thousand/t LiOH.

As far as the geothermal process in Ortenau is concerned (from thermal water production to reinjection), we have assumed expenses of USD 1.35 thousand/t LiOH. Once again, we have converted data collected on behalf of the responsible Federal Ministry for the Upper Rhine Valley to reflect the scale of the Ortenau project. We estimate the operating expenses for lithium hydroxide production to amount to USD 2.2 thousand/t LiOH (DLE process and lithium hydroxide synthesis), with the expenses for the first year (2024 planning period) estimated to come to USD 3.39 thousand/t LiOH (basis: adjustment of calculations for Salton Sea projects). Over the 30-year period, our model calculates a yield of 722.3 thousand t of LiOH. Disregarding any discounting effect, capital expenditure payments are mathematically distributed over USD 1.10 thousand/t LiOH.

We project that, after the ramp-up, the lithium hydroxide required for future battery generations would be produced on a zero-emissions basis in Ortenau at an operating cost of USD 3.60 thousand/t (LiOH). Expressed in terms of lithium carbonate equivalent, this corresponds to USD 3.17 thousand/t (LCE).

Ultimately, forecasts, in particular the development of the lithium hydroxide sales price, are subject to considerable uncertainty. The sensitivities of the revenue, and therefore the cash flows, especially with regard to the sales price parameter, are of equal importance when it comes to assessing the attractiveness of **Vulcan Energy Resources** Upper Rhine Valley project as the baseline scenario presented.

In actual fact, we assume, for the purposes of the baseline scenario that we have presented, that lithium hydroxide produced free of CO₂ emissions in an core industrial region of Europe will benefit from a relevant premium on the reference price calculated for Asia. The European battery industry, which is currently expanding, will have strong incentives to use the raw material mined by **Vulcan Energy Resources**.

This incentive effect forms the basis for the decision to apply a premium of 25% on the lithium hydroxide reference price calculated at USD 12.75 thousand/t for the model's baseline scenario as of 2024, meaning that the **Vulcan Energy Resources** forecast model is based on revenues of USD 15.95 thousand/t.

Base scenario revenue and cash flow series Stage 1 & 2

Fiscal year end: 31 Dec.

Figures in USD thousand	Periods as from 2030e									Periods from 2041e						
	2021e	2022e	2023e	2024e	2025e	2026e	2027e	2028e	2029e	2030e	2037e	2038e	2039e	2040e	2041e	2053e
Stage 1																
CAPEX FX: EUR/USD 1.10	4,000	49,806	0	0	0	0	0	0	0	0	25,000	0	0	0	0	0
LiOH Volume (t)			1,498	1,498	1,498	1,498	1,498	1,498	1,498	1,498	1,498	1,498	1,498	1,498	1,498	1,498
Price (USD thousand/t)			12.75	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95
Costs (USD thousand/t) well and geothermal			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cost (USD thousand/t LiOH) Direct extractions and Lithium			3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74
Revenue electricity sales			0	0	0	0	0	0	0	0	0	0	0	0	0	0
Revenue LiOH			19,103	23,898	23,898	23,898	23,898	23,898	23,898	23,898	23,898	23,898	23,898	23,898	23,898	23,898
Government royalty (5%)			955	1,195	1,195	1,195	1,195	1,195	1,195	1,195	1,195	1,195	1,195	1,195	1,195	1,195
Costs geothermal and LiOH			5,600	5,600	5,600	5,600	5,600	5,600	5,600	5,600	5,600	5,600	5,600	5,600	5,600	5,600
Working capital (commitment of funds)			5,600	0	0	0	0	0	0	0	0	0	0	0	0	0
Cash flow contribution Stage 1	-4,000	-49,806	6,948	17,103	17,103	17,103	17,103	17,103	17,103	17,103	-7,897	17,103	17,103	17,103	17,103	17,103
Stage 2 (Ortenau)																
CAPEX FX: EUR/USD 1.10	4,000	148,280	497,561	144,756	0	0	0	0	0	0	0	150,000	0	0	0	0
LiOH Volume (t)			9,504	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760
Price (USD thousand/t)			15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95	15.95
Costs (USD thousand/t) well and geothermal			1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
Cost (USD thousand/t LiOH) Direct extractions and Lithium			3.39	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24	2.24
Revenue electricity sales			4,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Revenues LiOH			151,594	378,984	378,984	378,984	378,984	378,984	378,984	378,984	378,984	378,984	378,984	378,984	378,984	378,984
Government royalty (5%)			7,580	18,949	18,949	18,949	18,949	18,949	18,949	18,949	18,949	18,949	18,949	18,949	18,949	18,949
Costs geothermal and LiOH			45,031	85,277	85,277	85,277	85,277	85,277	85,277	85,277	85,277	85,277	85,277	85,277	85,277	85,277
Working capital (commitment of funds)			32,200	31,920	0	0	0	0	0	0	0	0	0	0	0	0
Cash flow contribution Stage 2	-4,000	-148,280	-497,561	-73,972	252,838	284,758	284,758	284,758	284,758	284,758	284,758	134,758	284,758	284,758	284,758	284,758

Source: SRH AlsterResearch

Investment will have paid for itself within a four-year period following the ramp-up of the

The modelled surpluses in cash inflows for 2024e to 2027e of USD 960 million cover capex of USD 848 million. Following the ramp-up phase (2022 to 2023), which will be characterised by high capex, the investment will have paid for itself within a four-year period.

Sensitivity analysis revenue and cash flow series Stage 1 & 2 with variation of LiOH sales price

Fiscal year end: 31 Dec.

Figures in USD thousand	Periods as from 2030e									Periods from 2041e						
	2021e	2022e	2023e	2024e	2025e	2026e	2027e	2028e	2029e	2030e	2037e	2038e	2039e	2040e	2041e	2053e
LiOH selling price (USD thousand/t) 10.20																
Revenue LiOH	0	0	19,103	112,225	257,639	257,639	257,639	257,639	257,639	257,639	257,639	257,639	257,639	257,639	257,639	257,639
Net income	-2,800	-373	-9,617	2,558	68,006	68,006	68,006	68,006	68,006	68,006	68,379	76,457	92,676	99,432	100,598	107,598
Cash flow contributions Stage 1 & 2	-10,800	-197,926	-486,491	-118,569	101,565	133,485	133,485	133,485	133,485	133,485	108,325	-20,137	122,912	120,017	119,517	116,517
LiOH selling price (USD thousand/t) 12.75																
Revenue LiOH	0	0	19,103	140,281	322,048	322,048	322,048	322,048	322,048	322,048	322,048	322,048	322,048	322,048	322,048	322,048
Net income	-2,800	-373	-9,617	18,675	108,298	108,298	108,298	108,298	108,298	108,298	108,671	116,748	132,968	139,723	140,890	147,890
Cash flow contributions Stage 1 & 2	-10,800	-197,926	-486,491	-98,823	145,486	177,406	177,406	177,406	177,406	177,406	152,246	23,784	166,833	163,938	163,438	160,438
LiOH selling price (USD thousand/t) 14.05																
Revenue LiOH	0	0	19,103	154,590	354,897	354,897	354,897	354,897	354,897	354,897	354,897	354,897	354,897	354,897	354,897	354,897
Net income	-2,800	-373	-9,617	26,895	128,847	128,847	128,847	128,847	128,847	128,847	129,220	137,297	153,517	160,272	161,439	168,439
Cash flow contributions Stage 1 & 2	-10,800	-197,926	-486,491	-88,752	167,886	199,806	199,806	199,806	199,806	199,806	174,646	46,184	189,233	186,338	185,838	182,838
LiOH selling price (USD thousand/t) 17.20																
Revenue LiOH	0	0	19,103	189,240	434,443	434,443	434,443	434,443	434,443	434,443	434,443	434,443	434,443	434,443	434,443	434,443
Net income	-2,800	-373	-9,617	46,799	178,607	178,607	178,607	178,607	178,607	178,607	178,980	187,057	203,277	210,032	211,199	218,199
Cash flow contributions Stage 1 & 2	-10,800	-197,926	-486,491	-64,365	222,129	254,049	254,049	254,049	254,049	254,049	228,889	100,427	243,476	240,581	240,081	237,081

Source: SRH AlsterResearch

With regard to the revenue from electricity sales (stage 2, assumption: 355 GWh per year), we have merely included a placeholder in our model in which the revenue corresponds to the burdens associated with energy use calculated on the cost side. This simplification allows us to prevent the appeal of the lithium story being overshadowed by the return aspect relating to energy feed-in.

12. DCF model and possible dilution path

Our baseline scenario results in a net present value for **Vulcan Energy Resources'** Upper Rhine Valley project of USD 769.2 million (equivalent to approx. EUR 700 million or AUD 1.3 billion as of the beginning of March 2020).

DCF model Vulcan Energy Resources		Fiscal year end: 31 Dec.									Periods				Periods		
		2021e	2022e	2023e	2024e	2025e	2026e	2027e	2028e	2029e	as from 2030e	2037e	2038e	2039e	2040e	from 2041e	2053e
Figures in USD thousand																	
Cash flow contribution Stage 1		-4,000	-49,806	6,948	17,103	17,103	17,103	17,103	17,103		-7,897	17,103	17,103	17,103		17,103	17,103
Cash flow contribution Stage 2		-4,000	-148,280	-497,561	-73,972	252,838	284,758	284,758	284,758		284,758	134,758	284,758	284,758		284,758	284,758
Group data																	
Depreciation		0	533	13,739	46,910	56,560	56,560	56,560	56,560		56,027	44,488	21,317	11,667		10,000	0
EBT		-4,000	-533	-13,739	56,074	228,198	228,198	228,198	228,198		228,732	240,271	263,441	273,092		274,758	284,758
Income tax (long-term 30%)		-1,200	-160	-4,122	16,822	68,459	68,459	68,459	68,459		68,619	72,081	79,032	81,928		82,428	85,428
Net income		-2,800	-373	-9,617	39,252	159,739	159,739	159,739	159,739		160,112	168,190	184,409	191,164		192,331	199,331
Free cash flow	within the DCF model	-10,800	-197,926	-486,491	-73,691	201,482	233,402	233,402	233,402		208,242	79,781	222,829	219,934		219,434	216,434
Net present value	excl. interest	-9,126	-151,911	-339,135	-46,658	115,867	121,910	110,727	100,569	91,344	37,744	13,134	33,318	29,868		8,531	7,642
Basic data																	
Total net present value 2021e to 2054e		769,582	BETA		1.20												
Net present value period 2020e		-2,605	implied market return		8.75%												
Terminal value (periods from 2055e)		0	risk-free return		2.00%			... of the WACC					... the LiOH sales price				
Total enterprise value		766,977	Debt ratio		0.00%												
Liabilities (as at the end of 2019)		0						10.60%	699,054		10.20		149,336				
Cash and cash equivalents (end of 2019)		2,213						10.35%	733,328		12.75		421,820				
Equity value		769,189						10.10%	769,189		14.05		560,787				
								9.85%	806,723		15.95		769,189				
								WACC	10.10%		17.20		897,306				
									9.60%	846,020							

Quelle: SRH AlsterResearch

Our valuation model reacts to a variation in the lithium hydroxide price by USD 1.0 thousand/t with a change in the net present value of USD 107 million (EUR 97 million).

We have assumed, for the sake of simplicity, that **Vulcan Energy Resources** will finance the capital expenditures to be made (USD 848 million up to mid-2024 according to our forecast, assuming a constant EUR/USD exchange rate of 1.10) exclusively using equity, instead of taking debt on board as an alternative.

We have modelled a "dilution path" to show the effect with regard to the valuation per share (table on page -22-). As a result, we expect that **Vulcan Energy Resources** will have issued over 483 million shares by mid-2024 (currently: 48.50 million, plus option rights, or rights linked to the project progress or share price performance). Accordingly, we have calculated the appropriate valuation per share by dividing the calculated enterprise value of USD 769.2 million by the hypothetical number of shares issued in the period leading up to mid-2024.

Dilution path

	March 2020	Mid 2020	End of 2020	Mid 2021	End of 2021	Mid 2022	End of 2022	Mid 2023	End of 2023	Mid 2024
Required funding (rough), in USD million										
- Provision for future use with a time lead -										
Capital requirements, cumulative, in USD million		4	8	33	132	223	567	704	776	848
Net cash provided by operating activities, cumulative, in USD million									11	47
Acquisition Equity, accumulated, in USD million		5	10	37	137	237	567	707	777	812
Event										
			PFS		DFS					
Stage 1					DLE Start of construction	Lithium Start of construction	DLE + Lithium Completion			
Stage 2, Plant 1 (Ortenau, 4 wells)							Geothermal energy Start of construction	DLE + Lithium Start of construction	Geothermal + DLE + Lithium Completion	
Stage 2, Plant 2 (Ortenau, 6 wells)								Geothermal energy Start of construction	DLE Start of construction	Geothermal energy + DLE Completion
Acquisition of equity										
Assumed share price, in EUR	0.15	0.45	1.20	1.25	1.35	1.70	1.80	2.60	2.80	3.05
Capital increase, in EUR million		4	5	25	91	91	300	127	64	32
FX EUR/USD	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Capital increase, in USD million		5	5	28	100	100	330	140	70	35
Capital increase in number of shares (in million)		9.09	3.79	20.00	67.34	53.48	166.67	48.95	22.73	10.43
Number of shares End of period, diluted (in millions)	80.84	89.93	93.72	113.72	181.06	234.53	401.20	450.15	472.88	483.31
Equity valuation stock exchange, in USD million	13	45	124	156	269	439	794	1,287	1,456	1,622
Dilution effect, factor	9.6	3.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2
Dilution effect, in EUR/share	1.30	1.03	0.36	0.40	0.38	0.47	0.47	0.67	0.63	0.68
Company value according to progressive DCF, in USD million	769	786	827	878	922	1,156	1,206	1,736	1,821	1,981
per share, based on number of shares in mid 2024, in EUR	1.45	1.48	1.56	1.65	1.73	2.17	2.27	3.27	3.43	3.73

Source: SRH AlsterResearch

When the pre-feasibility study is presented (scheduled for the end of 2020), we can likely assume an equity valuation of at least USD 125 million on the capital markets. Three months after the pre-feasibility study was available for the exploration company *Advantage Lithium* operating in Argentina (lithium production from brine deposits), a takeover offer was submitted by *Orocobre* (February 2020). *Orocobre* is offering the equivalent of USD 9.1 million per 1 million t of the estimated resource (share to be acquired: 0.65%, resource on 100% basis: 7.32 million t, share of resource through Advantage Lithium: 75%, bid: 15.1 million shares at AUD 3.34 each).

Using a variety of model assumptions, we arrive at an appropriate valuation per share of EUR 1.45 (or AUD 2.45).

13. Resources as a valuation aspect

Based on a lithium concentration that is estimated to come to 181 mg/l, a resource estimate of a total of approx. 13.9 million t LCE (JORC-compliant: inferred mineral resource, not mineral reserve) has been indicated for the **Vulcan Energy Resources** Upper Rhine Valley project, which has so far been defined as encompassing stage 1 & 2. This puts **Vulcan Energy Resources** at the very top of the rankings for the peer group of exploration projects in Europe – all of which are based on hard rock deposits. Among the exploration projects being forged ahead with in North and South America, especially in Argentina, involving lithium-rich groundwater (brine), *Lithium Americas* stands out with a resource estimate of 24.6 million t LCE.

Comparative Lithium Exploration Projects

Issuer	Abbreviation	Project/Region	Resource category	Resource grade	Resource	Li	LCE	Market assessment
		Mineral		mg/l Li % Li ₂ O	kt	kt	kt	in MEUR
Vulcan Energy Resources	ASX:VUL	Upper Rhine Graben	inferred	181	2,620	13,947	8.61	
American brine resources								
<i>Lithium Americas Corp.</i>	TSX:LAC	Cahchari-Olaroz/Argentina	measured&indicated Inferred	592 592		19,854 4,723		397.08
<i>Millennial Lithium Corp.</i>	TSVX:ML	Pastos Grandes/Argentina	measured&indicated inferred Reserves	428 428 439		4,100 798 943		71.53
<i>Orocobre Limited</i> - Production started -	ASX:ORE	Salar d Olaroz/Argentina	measured&indicated	690		6,400		528.32
<i>E3 Metals Corp.</i>	TSXV:ETMC	Alberta/Canada	inferred	73		6,700		6.56
European Hard rock deposits								
<i>European Metals Holdings Limited</i>	ASX:EMH	Cinovec/Czech Republic Mica (Zinnwaldite)	indicated&inferred	0.42%	696	1,347	7,171	25.14
<i>Infinity Lithium</i>	TSVX:ILI	San Jose/Extremadura, Spain Mica (Zinnwaldite)	indicated&inferred	0.61%	111	316	1,681	1.99
<i>Savannah Resources</i>	AIM:SAV	Mina do Barroso/Portugal Spodumene	measured&indicated inferred	1.06% 1.06%	15 12	74 59	391 316	30.80
<i>European Lithium</i>	ASX:EUR	Wolfsberg/Austria Spodumene	measured&indicated inferred	1.17% 0.78%	6 5	34 17	182 90	30.40
<i>Keliber</i>		Severäl/Finland Spodumene	indicated&inferred Reserves	1.16% 1.04%	9 7	51 36	272 192	
<i>Rio Tinto</i>		Jadar/Serbia Jadarite	indicated&inferred	1.86%	136	1,171	6,232	

Source: Company, SRH AlsterResearch

For the stock market valuation of **Vulcan Energy Resources**, no relation to the size of the lithium resource can be established so far. In actual fact, the resource for the Upper Rhine Valley project has not been categorised, not even as an indicated resource. Nevertheless, the resources communicated only in December 2019, which will also appear for the first time this year (2020) in numerous comparative analyses performed by various issuers, will attract increasing attention among investors due to its outstanding magnitude.

14. SWOT analysis

<p>Strengths</p> <ul style="list-style-type: none"> ■ Location: Close proximity to the European battery industry which is currently being established, short transportation distance (carbon footprint, 1st aspect) ■ Largest JORC-compliant lithium resource in Europe (inferred mineral resource) ■ Shortened implementation process for pilot plant in Insheim, as established geothermal site will be used as a basis ■ Carbon footprint, 2nd aspect: Lithium production using geothermal energy, without polluting the environment with emissions, waste material or toxic substances. ■ Lithium is separated within a matter of hours, eliminating external interference factors 	<p>Opportunities</p> <ul style="list-style-type: none"> ■ Rapid growth in lithium demand among the European battery industry ■ Contribution to an independent European lithium supply chain (supply aspect, short transportation distances) creates an incentive for the battery industry to pay a premium over the lithium reference price ■ Low-cost asset: Opportunity for operating costs at the lower end/in the lower quartile of the global peer group cost curve ■ Income from electricity feed-in as a second source of revenue besides lithium sales
<p>Weaknesses</p> <ul style="list-style-type: none"> ■ Funds required for project implementation have yet to be raised ■ Investment lead time will take more than two years 	<p>Threats</p> <ul style="list-style-type: none"> ■ Preliminary feasibility study (PFS) still outstanding (scheduled for the end of 2020) ■ In the short term, the reference price for lithium based on imports in China/Korea/Japan could come under pressure and put a damper on investor sentiment. ■ Approval procedures, in particular legal action against authorisations granted, could delay implementation

Source: SRH AlsterResearch

15. Conclusion & investment recommendation

Irrespective of how the supply and demand situation in Asia will develop: securing the raw material supply for Europe's battery industry is a challenge that puts a European lithium producer in a strong position. In actual fact, we assume, for the purposes of the baseline scenario that we have applied, that lithium hydroxide produced free of CO₂ emissions in an core industrial region of Europe will benefit from a relevant premium on the reference price calculated for Asia. The European battery industry, which is currently expanding, will have strong incentives to use the raw material mined by Vulcan Energy Resources.

The resource statement communicated in December 2019 is also likely to appear for the first time this year (2020) in numerous comparative analyses performed by various issuers and, due to its outstanding magnitude - it has been put at a total of approx. 13.9 million t LCE in JORC-compliant terms (inferred mineral resource, not mineral reserve) - is likely to attract increasing attention among investors.

Following the ramp-up phase (2022 to 2023), which will be characterised by high capex, the investment will have paid for itself within a four-year period. Fundraising remains a key aspect of the implementation of the Upper Rhine Valley project – following the comparatively modest use of funds for stage 1 in the amount of approx. USD 55 million, the first expansion stage in the Ortenau region four doublets, DLE, also capacity for lithium hydroxide synthesis) will require an investment of USD 425 million (estimates: SRH AlsterResearch). By discounting our modelled cash flow projection, we have put the appropriate enterprise value at USD 769 million (at the beginning of March 2020, corresponds to around EUR 700 million or AUD 1.3 billion).

Assuming dilution, which will occur in the course of the process involved in raising the additional equity required, we have modelled an appropriate valuation per share of EUR 1.45 (or AUD 2.45).

The investment recommendation for the initial assessment is "buy".

16. Disclaimer and legal comments with regards to § 34b WpHG und FinAnV

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The preparation of this publication is based on a contractual relationship between the issuer and SRH AlsterResearch AG. No other possible conflicts of interest within the meaning of the FinAnV exist at the time of publication of this publication.

16.2 Declaration according to § 34b WpHG and FinAnV about additional information (as of 03/04/2020):

This financial analysis has been made available to the issuer in a previous version prior to its publication.

This publication is updated whenever SRH AlsterResearch AG believes that the share price may be affected. The discontinuation of regular coverage of events relating to the issuer is indicated in advance.

16.3 Essential basics and scales of the value judgements made in this document:

The evaluations that underlie the investment judgements of SRH AlsterResearch are based on generally recognised and widely distributed methods of fundamental analysis, such as the DCF model, Peer-Group comparisons, possibly a sum-of-the-parts model.

16.4 Meaning of an investment judgement

- Buy** The analysts of SRH AlsterResearch believe that the share rate will increase in the next twelve months unless the text explicitly names a different time horizon.
- Sell** The analysts of SRH AlsterResearch believe that the share rate will drop in the next twelve months unless the text explicitly names a different time horizon.

Relevant supervisory authority:

Bundesanstalt für Finanzdienstleistungsaufsicht
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16.5 History of investment recommendations for Vulcan Energy Resources Limited

Date	Analyst	Investment recommendation	Price target	Price basis (end of previous day Frankfurt)
03/04/2020	Oliver Drebing	Buy	EUR 1.45	EUR 0.159